SIXTY-NINTH YEAR

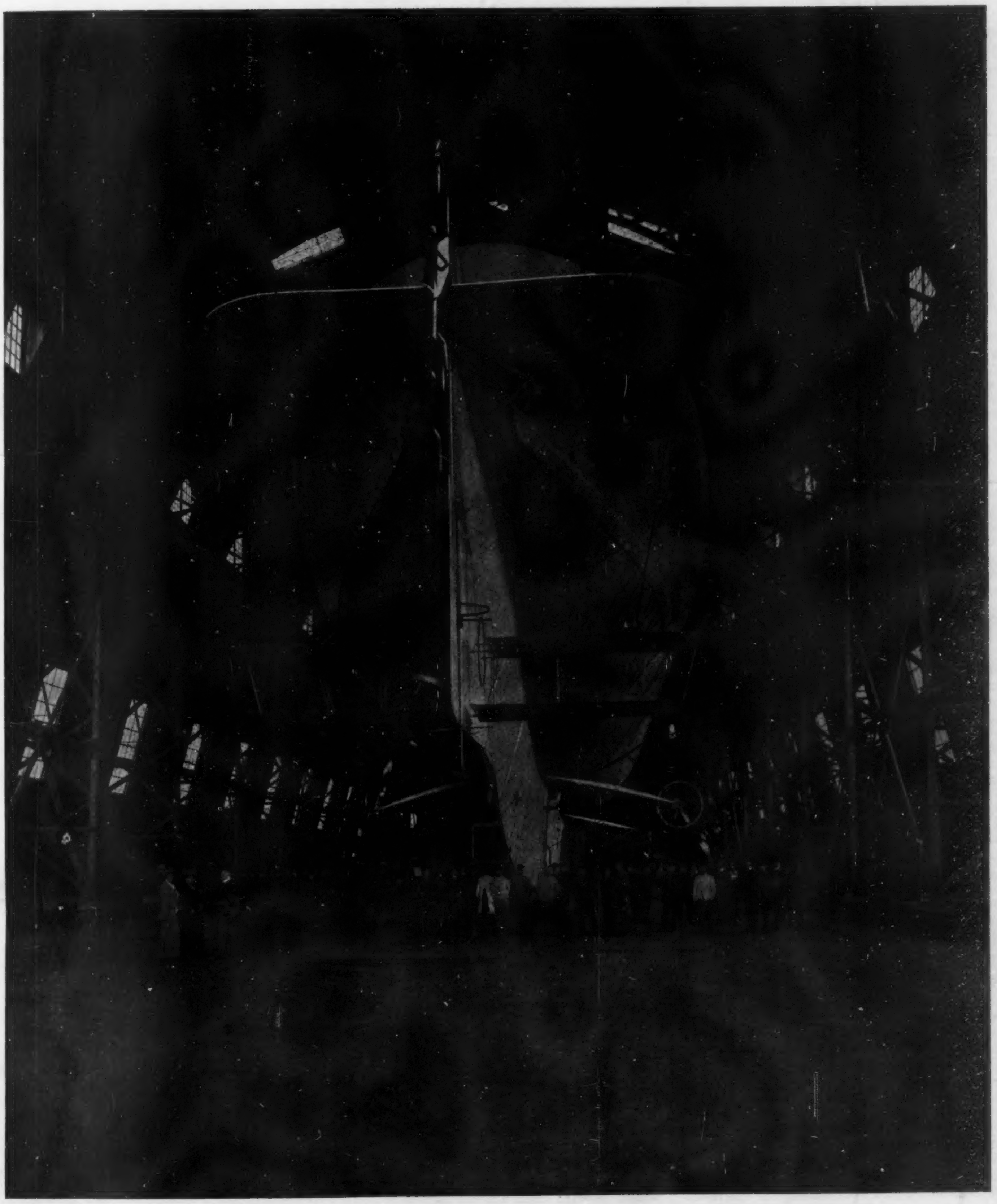
SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

VOLUME CIX
NUMBER 9.]

NEW YORK, AUGUST 30, 1913

[PRICE 10 CENTS
$3.00 A YEAR



THE NEW GERMAN DIRIGIBLE AIRSHIP "V1" IN THE GREAT SHED AT DÜSSELDORF.—[See page 164.]

SCIENTIFIC AMERICAN

Founded 1845

NEW YORK, SATURDAY, AUGUST 30, 1913

Published by Munn & Co., Incorporated. Charles Allen Munn, President
Frederick Converse Beach, Secretary and Treasurer
all at 361 Broadway, New York

Entered at the Post Office of New York, N. Y., as Second Class Matter
Trade Mark Registered in the United States Patent Office

Subscription Rates

Subscription one year $3.00
Postage prepaid in United States and possessions, Mexico, Cuba, and Panama
Subscriptions for Foreign Countries, one year, postage prepaid, 4.50
Subscriptions for Canada, one year, postage prepaid, ... 3.75

The Scientific American Publications

Scientific American (established 1845) . . . . per year, $3.00
Scientific American Supplement (established 1876) . " " 5.00
American Homes and Gardens . . . . " " 3.00
The combined subscription rates and rates to foreign countries including Canada, will be furnished upon application.
Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 361 Broadway, New York

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

A Costly Lack of Co-ordination

HOW absolutely necessary it is to lay out and execute municipal improvements of an engineering character upon a carefully thought out and co-ordinated plan is strikingly illustrated in the case of the three great bridges which have been built during the past eighteen years across the East River, New York. These monumental structures, the Queensboro Cantilever Bridge and the Williamsburg and Manhattan Suspension Bridges—the two last-named being the greatest structures of their kind in existence—represent together a draught upon the city's treasury of over $72,000,000. Nevertheless, not one of them is today being utilized to its full capacity, and two of them at least, in spite of the fact that they have been completed for several years, are not even yet performing their principal function as links in the rapid transit system of Greater New York. Indeed, it is only within the last few weeks that a stretch of four-track subway, built to form a loop connection between two of the three bridges, which has lain idle for several years, has been put in partial operation, with two of its four tracks in service. Furthermore, it must be several years before the Queensboro and Manhattan Bridges, representing, together, an investment of about $50,000,000, can be brought into full service as parts of the rapid transit routes.

Such haphazard and grossly extravagant methods in the conduct of municipal affairs is without a parallel; and the student of civic management knows not whether to be more astonished at the political conditions which rendered such wild extravagance possible, or at the financial stability of a city that could stand this tremendous strain upon its resources.

The construction of these engineering white elephants—for such they have been for a number of years—was entered upon without any comprehensive view of the transportation problem, or any intelligent conception of their proper rôle as forming part of the city's thoroughfares.

"The city is growing by leaps and bounds," said the city fathers of those days, "the present transportation facilities are inadequate; the people in increasing numbers wish to pass from Long Island to Manhattan; the East River is an obstacle; let us build bridges." And the bridges were built.

The most that can be said in extenuation is that it was not understood then so clearly as it is to-day, that such great bridges can realize their full usefulness only if they form sections of the important avenues of travel. It is understood to-day that bridge terminals are a mistake, serving, as they do, to promote congestion at specified points. Traffic should flow across a bridge with as much freedom as it does through any broad avenue on solid ground. The planning of great bridges should be done contemporaneously with the planning of facilities by which the various means of travel: trolley, elevated, or subway, will be able to make full use of them on the very day of their opening. Thanks to the good work done by the Public Service Commission and the Board of Apportionment, the East River bridges have now been brought into their proper relation to the vast extensions of our subway systems which are under construction; and before many years have passed it is probable that these grand engineering works will be rendering a service to New York city proportionate to their great carrying capacity and the enormous sums spent upon their construction.

Wind Pressure on Ocean Liners

A FEW weeks ago we offered the following problem for the consideration of the readers of the SCIENTIFIC AMERICAN: "The largest transatlantic liner now under construction will present to a head wind a cross-sectional area above water, including smokestacks, masts, etc., of about 9,500 square feet. If the ship were steaming at a reduced speed of 15 knots against a head wind of 65 miles velocity, how much horse-power would be necessary to overcome the wind pressure alone?"

We offered this problem in the conviction that the majority of our readers had little conception of the heavy draught that is made upon the effective horsepower of a large ship to meet the resistance due to wind pressure alone—an impression which is confirmed by the fact that the results arrived at by our correspondents are generally from 50 to 75 per cent less than the actual figures. This discrepancy is usually due to the fact that too low a unit wind pressure has been used in making the calculations.

The question of wind resistance has both a popular and academic interest; and that it is of serious economic importance will be understood when we state that our investigation of the problem shows that in a transatlantic liner of the largest size, say of 100 feet beam, 950 feet length, and, let us say, 60,000 horse-power, no less than 20 per cent of the horse-power or about 12,000, would be consumed in overcoming head-wind resistance when the ship was steaming at 15 knots against a 65-mile gale—and we believe that this estimate is, if anything, rather below than above the actual amount.

Our correspondence with several naval authorities here and abroad deepens the conviction that here is an element in the propulsion of ships and particularly of the giant ships of to-day, which has never received the careful investigation which its importance demands. Thus, a leading authority on model tank investigation writes us: "The question of the air resistance for ships has never been solved with great accuracy so far as I know;" and our answers from naval architects vary all the way from "compared with the water resistance, air resistance is of comparatively little importance" to the statement: "in the case of ships of the size of the 'Imperator,' as much as one third of the horse-power might be consumed in overcoming air resistance in a heavy gale."

Fundamental to the problem is the question of air-pressure per unit of surface over large areas such as are here considered. Some thirty years ago, when Sir Benjamin Baker was designing the Forth Bridge, he found himself saddled by the British government with a unit pressure of 56 pounds per square foot—a fact which should temper judgment with mercy on the part of those critics who complain of the unnecessary weight and bulk of the structure. Our own American Society of Civil Engineers has compromised on thirty pounds per square foot, as a basis on which to design the wind-bracing of roofs, bridges and tall buildings. One naval authority tells us that he would assume not less than 40 pounds per square foot as the unit pressure in the problem under consideration, and yet another considers that 27 pounds would be ample. Some recent investigations of wind pressure conducted by our Government would cut even this last figure in half; although we are satisfied that the results obtained in this case were altogether too low.

For our present purpose, we will take 30 pounds per square foot as the unit pressure; but because of the long and finely tapering bow which represents 5,000 square feet of the total projected area, we must be careful to make a proper reduction for the first fifty feet of the ship exposed above the water line. Opinion varies as to the reduction which should be made in the unit pressure as applied to the bow; some would use only four or five pounds and others would go as high as eighteen or twenty. We will assume a pressure of 10 pounds per foot, which gives a total end-on pressure for the bow of 50,000 pounds. Above the bow rises some thirty feet of superstructure which presents a practically flat surface against the wind, and the pressure on this area of 3,000 square feet will add another 90,000 pounds to the load. To this we should add 1,500 square feet, representing the projected area of the foremast and the forward smokestack; and since these present a rounded surface to the wind, we will reduce the unit pressure to 20 pounds, which will add another 30,000 pounds to the resistance.

We have now exhausted the 9,500 square feet of area presented normally to the wind by the total cross-section of the ship; but in a vessel 950 feet in length, the intervening spaces between successive structures are so great, that we must make a further addition. We shall find that the second and third smokestacks, the mainmast, the 80 or more lifeboats, the projecting deck houses, the cranes, the standing gear in the way of stays, shrouds, etc., will add at least another 4,000 feet upon which the wind impinges. If we apply the same reduced unit pressure of 20 pounds per square foot to this, another 80,000 pounds must be added to the total. Finally, we have to consider the skin friction and eddy-making, which, if we take account of the thousands of portholes, the hundreds of stanchions supporting the deck, the partial-vacuum effect of the square ends of the wide deck structures and of the broad stern of the ship itself, might easily add another 25,000 pounds to the total.

In summing up then, we find that there is a total of 275,000 pounds of atmospheric resistance, due to the wind and the speed of ship; and a simple calculation shows that to overcome this, at a speed of 15 knots, would require from 12,000 to 13,000 effective horse-power, or say about 20 per cent of the total effective horse-power of the ship.

Now here is a subject, which, if our calculations are approximately correct, may well be commended to the consideration, not merely of the builders of large ocean liners, but of smaller craft of moderate dimensions, such as torpedo boats and destroyers, which are called upon to steam at high speeds against winds of considerable strength.

Preventing Corrosion of Iron and Steel

AS a part of its investigations relating to efficiency in mining, the Bureau of Mines has undertaken to develop a method of preventing the corrosion, by acid water from mines, of iron and steel used in mine equipment. A paper entitled, "An electrolytic method of preventing corrosion of iron and steel," describes experiments in connection with an electrolytic method of preventing corrosion. The results appear to justify the hope that the method may be applied successfully for the protection of iron and steel in the construction of mining equipment, as well as for the protection of structures exposed to the acid waters of streams.

According to the electrolytic theory of corrosion, the corrosion of iron is an electrolytic process. The iron goes into solution as ferrous ions, and these ferrous ions are oxidized by the oxygen present in the water to ferric ions and precipitated as ferric hydroxide or iron rust. Simultaneously with the formation of the ferrous ions, hydrogen is liberated on the surface of the iron. The formation of ferrous ions and the liberation of hydrogen are accompanied by a transfer of electricity. The electric current flows through the metal from the point where hydrogen is liberated to the point where iron is dissolved; and through the electrolyte from the point where iron is dissolved to the point where hydrogen is liberated.

If, now, a counter electromotive force be imposed, the current may be made to flow in the opposite direction, and the solution of the iron may be prevented. This fact has been made use of previously in an electrolytic method for the protection of boilers against corrosion. The method consists in submerging a bar of zinc in the boiler water and connecting the zinc electrically with the boiler plates.

In the experiments of the Bureau of Mines, carbon was used as the anode in place of zinc, and the E. M. F. required was furnished by a storage battery.

Experiments were made on steel plates 1 inch by 2½ inches immersed in sulphuric-acid solutions. Suitable arrangements were provided for renewing the acid and for stirring the electrolyte. It was found that the current density required to protect the plates depends on the strength of the acid solution, the amount of oxygen gas present in the electrolyte, and the acid concentration. The first-named factor is probably of least importance, especially in dilute solutions.

The rate of flow of electrolyte over the surface of the metal is by far the most important factor.

With the lowest rate of stirring used in the experiments—35 revolutions per minute—and in acid concentrations not greater than 1/100 normal (500 parts per million), a current density of from 0.5 to 0.8 milliamperes per square inch reduced the corrosion loss to a negligible quantity, whereas with the stirrer rotating at a speed of 450 revolutions per minute and a current density of 2.0 milliamperes per square inch the corrosion loss amounted to 25 per cent of the loss on the unprotected plate.

It was found that the current density required can be calculated from the loss in weight of the metal under the given conditions when not protected and the electrochemical equivalent. Taking 1 milliampere per square inch and 5 volts as current density and E. M. F. required to prevent corrosion under given conditions, then the power consumption per square foot protected surface would be approximately 0.75 watts, and the electric energy would be 6.6 kilowatt hours per square foot of surface per year. These laboratory tests were supplemented by tests on a large scale with steel plates immersed in the Monongahela River at Braddock, Pa., the waters of which contain acid from the bordering steel mills and other industrial plants.

Engineering

Growth of the British Navy.—The First Lord of the British Admiralty, reporting on the growth of the British navy, recently stated that the navy would increase in the next eighteen months as follows: A torpedo boat destroyer once a week for the next nine months, a light cruiser every thirty days for the next twelve months, and a super-dreadnought of the latest type every forty-five days for the next eighteen months.

Completion of Ambrose Channel, New York.—The Army engineers have reported that the deepening and widening of Ambrose Channel leading into New York Harbor is finished, except for a few minor details, and no further appropriations for construction will be needed. This great artificial channel is 7 miles long, 2,000 feet wide and 40 feet deep at mean low tide. At night it is so brilliantly lighted by buoys that the largest ocean steamers can enter with perfect safety. The work was begun in 1901.

The New Gladstone Dock at Liverpool.—The fine new Gladstone Dock at Liverpool is 1,020 feet long, 120 feet wide at the entrance, and carries a depth of water over the sills of 46 feet at high water of ordinary spring tides. This dock is the first installment of a scheme involving the expenditure of $16,000,000. The proposed work includes also an entrance lock over 870 feet in length and 130 feet in width, and in the inside dock area there is to be a half-tide dock of 14¾ acres, two branch docks each 400 feet wide, with a pier between them over 1,300 feet in length.

A Feat in Stone Cutting.—Our contemporary *Engineer* calls attention to an interesting work of stone cutting connected with the laying of underground trolleys crossing the stone Pont Neuf, Paris. It was necessary to cut through the solid stone masonry two trenches, 4 feet wide and 6 feet deep. This would be an interminable task if it were cut by masons in the ordinary way. The work is being done by an electric motor connected to a drum, from which endless cutting wires are carried overhead and around sheaves placed in pits which have been sunk to the depth of the trench to be cut.

Battle Efficiency of the United States Navy.—The final standing in battle efficiency of the U. S. Navy shows that in the battleship class the "Idaho" is in the lead, while in the torpedo class the list is headed by the destroyer "Whipple." Out of a possible 100 points, the "Idaho," the winner of the pennant among battleships, scored 100 points for gunnery, and 87.8 for engineering, the final merit mark being 94.6. This ship is in command of Capt. W. L. Howard. In the torpedo class, the destroyer "Whipple" stands first, with 98.7 for gunnery, 91.5 for engineering, and a final merit mark of 95.9. Her commanding officer is Lieut. M. K. Metcalf.

Tracks Should be Scientifically Designed.—In an admirable paper read by E. B. Milner before a technical society, the writer draws attention to the need for a scientific investigation of the stresses to which the roadbed of a railway is subjected. He quotes from an investigation made by O. E. Selby, in which that authority found that after careful consideration of rail-loading, tie-bending, tie-bearing, depth of ballast, etc., the structure for a loading of 60,000 pounds per axle should be: Ties 7 inches deep, 9 inches wide and 8½ feet long, spaced 20 inches apart; the width of the roadbed, 24 feet for single track; ballast, 12 inches of stone and 12 inches of gravel. The rail should be 7 inches high with a 6-inch base.

The Loetschberg Tunnel in Operation.—The new Loetschberg Tunnel Route through the Alps which was officially opened on June 20th, is now in operation. The distance from Milan to Paris via the Mont Cenis tunnel is 586 miles; through the St. Gotthard 533 miles; through the Simplon and Lausanne it is 519 miles, and through the Simplon-Loetschberg and Neuchatel it is 513 miles. The new line is 43.47 miles in length. The tunnel itself is 9.07 miles long, and it cost about ten million dollars. The line is electrically operated by locomotives of 3,000 horse-power weighing 112 tons, and an overhead system using a current of 15,000 volts is employed. The locomotive can haul a 310-ton train up the maximum grade 2.7 per cent at the rate of 30 miles an hour.

Night Mortar Firing.—It is the opinion of the officers that witnessed the recent night target practice at Fort Hancock, New Jersey, with 12-inch mortars, that if the vessels of any foreign fleet attempted to enter the harbor by night they would be destroyed by the plunging fire from the mortar batteries. The practice was done at a target 12 feet square, which was towed by a tug. The first three and fifth shots hit within a 50-yard radius of the target; the fourth fell a trifle short, and the other five somewhat overshot the mark. Capt. H. S. Kerrick, attached to Fort Hamilton, said that the practice showed the mortars to be the best defenses for coast fortification, since mortar firing was now so advanced as to be fully as accurate as that of the heavy, direct-fire guns.

Electricity

Push-button Gas Lighting.—An electric gas valve has recently been invented in Paris which works with direct pressure on a gas outlet. It may not be generally known that only a slight pressure is needed to hold a valve down against the pressure of the gas. The device consists of a very small flat metal chamber screwed in between the fixture and the burner, and the gas enters the chamber containing a very simple electromagnet-valve device, then passes into the burner. Lighting is effected by letting gas into a small tube adjacent to the mantle which contains a platinum spiral traversed by the current to bring it to redness, then it is raised to white heat by catalytic action of the gas, producing a flame to light the mantle. Lighting follows instantly on pressing a button.

Electric Line for Constantinople.—The project for running a metropolitan electric line for Constantinople is well under way according to recent reports, and the scheme includes the formation of what is known as the Ottoman Metropolitan Company, capitalized at $5,000,000 for the purpose of building and operating the line. The concession for the enterprise has now been awarded to the Deutsche Bank who were the original promoters. From the starting point at Stamboul the line crosses the Golden Horn and reaches Pancaldi and Shishli, running throughout the course in double track. Work is to be finished as far as Pancaldi in 4½ years from October 1st, 1912, according to the terms of the contract, and the rest will follow within a 10-year period. A new bridge over the Golden Horn will be part of the work. Rights are also secured by the company for a branch line going from Eyoub to Dolma-Baghtcheh, also a line from Stamboul to Yenikapu.

Electrifying Paris Suburban Railroads.—M. Mazen, a prominent railroad official, gives some interesting information on the scheme for applying electric traction on the western suburban railroads in the region of Paris. The magnitude of the project will be seen from his statement that the railroads entering the three depots of St. Lagare, Montparnasse and Invalides have rolling stock amounting to 1,500 cars and 200 locomotives. It is likely that the direct current electric system at 650 volts will be adopted, and this will mean the use of about 500 motor cars, together with trailers. Sub-stations along the railroad line will furnish current to the third rail, and will receive their supply from three-phase 15,000-volt lines coming from the central stations. That the work is in progress will be noted from the fact that the contracts for two large power plants have already been awarded. These stations will be located at Moulineaux and Bezons, upon the Seine, and when completed they are to furnish upward of 100,000 horse-power, using steam turbine groups of 7,000 horse-power size. At a future date it is likely that the Rhone and Geneva will be called upon to furnish a large amount of current for Paris over a power line, and on the other hand there is a likelihood that the Lens coal mines in the north of France will also be called upon, using a 100-mile power line. A type of third rail will be used having collecting shoes rubbing either underneath or on top, and it will be well covered over, being mounted upon blocks of treated wood. The sub-stations will have from 1,000 to 2,000 horse-power rotary-converter sets which need no transformer, but will give a direct change of high-tension alternating current into continuous current at low voltage.

The St. Denis Steam-turbine Plant.—In view of the considerable additions which the great St. Denis steam-turbine plant has received of late, it will be timely to give a *resumé* showing the leading features of the station as at present installed. It will be remembered that the plant lies not far from Paris and is one of the sources of the city supply both for light and traction, including the extensive subway system. At present the station has five Brown-Boveri steam-turbine alternators of 4,000 kilowatts, four groups of 6,000 and one large one recently installed of 15,000-kilowatt (20,000 horse-power) capacity. These turbines work at 750 revolutions per minute and the alternators deliver 10,250 volts. Such groups serve to produce three-phase current, and the plant has also four 6,000-kilowatt groups used for two-phase current supply and running at 835 revolutions per minute. Two other turbine alternator sets are designed to produce either two-phase or three-phase current and use one turbine mounted with two different alternators on the same shaft. Condensation for the ten groups is taken care of by ten surface condensers in the basement, each one using an air pump driven by a direct-current 50 horse-power motor, while the large 15,000 kilowatt group has a condenser provided with a 60 horse-power motor for the air pump and a 250 horse-power circulation water pump. There are also four "polymorphic" dynamo groups, each one composed of two alternators (two-phase and three-phase) coupled to two 550-volt direct-current dynamos. Any of the machines can serve as a motor for driving the rest so as to have various supplies of current. For the direct current, the plant uses a small turbine set and also two large motor-generators of 1,200 kilowatt size and two of 600 kilowatts, working with storage batteries.

Science

Moving Pictures in Greek Schools.—A consular report states that the Minister of Education at Athens has opened negotiations for an early installation of no fewer than 4,000 natural color moving-picture machines, with supplies of films, for use in the State schools.

A New Method of Determining the Dew-point is described by Heygendorff in the *Physikalische Zeitschrift* as follows: Take a vessel of some metal that is a good conductor of heat; e. g., a silver or copper cup. Fill it with water, and introduce the bulb of a thermometer. Then add slowly some salt, such as sal ammoniac or hyposulphite of soda, the solution of which lowers the temperature of the mixture, meanwhile stirring the liquid with the thermometer. At the precise moment when the outside of the vessel becomes coated with moisture note the temperature registered by the thermometer. This is the dew-point temperature of the surrounding air.

Radium Emanation Therapy was discussed by Dr. Saubermann, of Berlin, in a recent lecture before the Röntgen Society in London. As reported in the London *Times*, the lecturer stated that in the whole range of diseases of metabolism, including gout, rheumatoid arthritis, nephritis, and arteriosclerosis, remarkable results had been obtained by the use of water artificially charged with radium emanation to a much higher degree than the water found in any natural spring. As to the claims put forth all over the continent by various spas, he said that in the majority of cases the amount of radium emanation in the water or the air was too small to have any physiological effect.

Air Currents at a Height of Fifty Miles above the earth are discussed by J. Edmund Clark in the *Quarterly Journal* of the Royal Meteorological Society, on the basis of observations made at many places in southern England and northern France of the drift of a particularly bright and persistent meteor train seen on the night of February 22nd, 1909. Mr. Clark himself saw the train for 104 minutes. The most remarkable conclusions drawn by the writer relate to the velocity of the upper winds at various levels, as indicated by the movement of the train. Thus it appears that between 49½ and 51 miles altitude the streak lay in a west wind of over 170 miles an hour, while at 51½ miles the current was almost from the east with a velocity approaching 200 miles an hour. These conclusions hardly agree with the prevailing conception of the stratosphere as a region of gentle winds.

Hail Insurance in Great Britain is fairly general in only two counties, viz., Bedfordshire and Huntingdonshire, where its prevalence is explained especially by the fact that these counties were visited by a very destructive hailstorm in August, 1906. The two counties just mentioned and parts of Cambridgeshire and Northamptonshire are subject to rather frequent hailstorms; but over the greater part of the British Isles loss from hail is so small as to be almost negligible from the standpoint of the underwriter. The British Board of Agriculture, which has been collecting information concerning hail insurance as carried on by British companies, has received prospectuses from six of these concerns; five of them charge a uniform premium per acre for the whole country, while the sixth follows the more equitable plan of varying the premiums according to the meteorological history of each section; i. e., the number of damaging hailstorms that have occurred within a ten-year period. The results of the Board's inquiries, together with a chart prepared by the Meteorological Office showing the number of days hail has been reported during July and August at different places in the United Kingdom in the ten years 1903–1912, are published in the *Journal* of the Board of Agriculture for March, 1913.

Recovery of Metals From Smelter Gases.—By means of Cottrell's method of electric precipitation appreciable amounts of precious metals have been recovered from smelter slime gases, which have been heretofore considered as waste products. At a prominent New Jersey copper smelting works a plant to treat gases arising from smelting slimes is already about completed and several smelting companies are preparing to install converters. The copper as recovered from the ore and as received at the electrolytic refinery, usually contains a considerable amount of silver, gold and other precious metals. During the electrolytic process most of these elements settle out from the electrolyte. This sediment or mixture, called slime, is then treated in another department for the recovery of the precious metals. This is usually done by drying the slime and driving off the volatile elements by means of a furnace treatment. Some of the silver is volatilized and even small quantities of gold. The heavier metals condense in the flue according to their relative weights. Gold is found in the flue dust near the exit from the furnace while silver, being lighter, is carried further along. At points further removed are found antimony, arsenic, selenium and other elements. The presence of zinc, arsenic and antimony seems to have an appreciable effect on the deposit of silver and samples of dust from such refineries have shown the amount of silver to range from 100 to nearly 2,000 ounces per ton.

Cooling Gas Engines in a New Way

IN most gas engines, heat is removed by circulating water around the cylinder and the exhaust valve. About thirty per cent of the heating value of the fuel thus passes into the metal of the engine. Besides, external water-cooling is the cause of many disadvantages under which the gas engine labors and which limit its size. There are also secondary effects. In order, for example, that the heat may flow from the inner surface of the metal, where it enters, to the outer surface, where it is removed, there must be a difference of temperature between these surfaces proportionate to the thickness. It is difficult in large engines to secure an adequate circulation about all parts of the cylinder-walls and piston, so that some parts may become hotter than others. These inequalities of temperature may set up stresses that are liable to crack a casting, or may cause preignition of the charge, especially if deposits of carbon or tar are formed. As a result, gas engines of large size cannot be worked continously at the maximum power which they can develop.

To overcome these difficulties Prof. Bertram Hopkinson of the University of Cambridge proposed, in a paper recently read before the Institution of Mechanical Engineers, to apply the cooling medium inside instead of outside the cylinder.

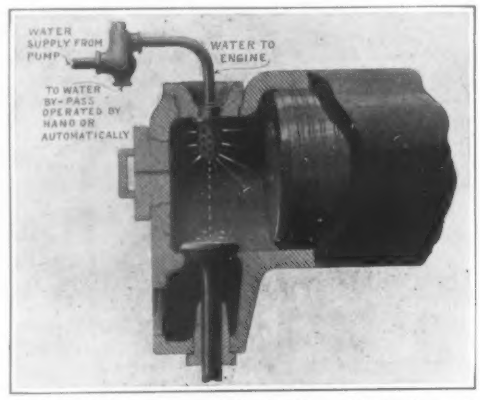
The idea of introducing water into an internal combustion engine is not new, as Prof. Hopkinson admits; but it has never been effectively carried out because the conditions which must be satisfied if the injected water is to act as an effective cooling agent have not been realized. Of these conditions the most important is that the water must be projected in comparatively coarse drops or jets, directly against the surfaces to be cooled, so that it reaches these surfaces in liquid form without much loss by evaporation. Furthermore, it must be distributed properly, so that each portion of the metal receives water in the proportion in which it receives heat. If the water be turned into steam before reaching the metal, it would exert little if any cooling effect. If the water is not properly distributed, those portions of the cylinder walls and piston which do not receive an adequate supply must lose by conduction to the properly cooled portion the heat which they receive, and, in consequence of the inequalities of temperature thus set up, an important advantage of Prof. Hopkinson's method of cooling (substantially uniform temperature) is lost.

While fine sprays have in the past proved useful for the prevention of pre-ignition and for the softening of the explosion, they are not effective for cooling. Prof. Hopkinson's method of internal injection is clearly revealed in the annexed illustration. Cold water is injected through a hollow casting which projects into the combustion chamber and which is provided with a number of holes or small nozzles about 1/32 of an inch in diameter. The jets thus formed are comparatively coarse. Even when projected into the flame, the water performs its function with but little evaporation on the way. The jets are directed to all parts of the surface of the combustion chamber and against the face of the piston.

But what about corrosion? By the simple device of regulating the amount of water injected in such a way that the temperature of the whole engine is maintained well above 100 deg. Cent., this apparently insuperable difficulty has been overcome. Every drop of injected water is boiled when it reaches the walls, and no liquid can accumulate to form sulphuric acid with the sulphur dioxide contained in most producer-gas. What little gas the large drops of water absorb is at once driven off when they strike the hot metal, because the water is almost instantly converted into steam.

It is sufficient to inject water on to the surface of the combustion chamber and the head of the piston only, the whole of the cooling of the barrel being effected by conduction into the piston which is itself kept cool by the projection of water onto the head when it is near the in-center. This, of course, is the opposite of what occurs in a jacketed engine, in which the heat flows from the piston into the jacketed barrel. By taking advantage of this fact, the application of water is confined to places where it can do no harm, none falling on the sliding surfaces. This is a point of some importance if the water contains much dissolved matter.

In his paper Prof. Hopkinson gives an account of some tests made with a 50 horse-power Crossley engine, rated at 40 brake horse-power, 11½ inches in diameter by 21 inches stroke, having a speed of 180 revolutions per minute. Only the external water-cooling system was removed. The engine was run continuously for 120 hours on an electrical load with coal gas. It developed during this period 43 brake horse-power on the average, and the average mean effective pressure was 101 pounds per square inch. When jacketed the engine would not develop more than 40 brake horse-power continuously without overheating, and mixtures giving a mean pressure of more than 100 pounds per square inch produced excessive maximum pressures (over 500 pounds) with violent thumping explosions. Water injection reduced the maximum pressure by over 100 pounds per square inch and made the explosions almost inaudible. The formation of the steam involved practically no thermodynamic loss. The



Prof. Hopkinson's method of internal injection of water to cool gas engines.

quantity of water used averaged 102 pounds per hour. The temperature of the engine varied from 150 deg. to 180 deg. Cent. No water was visible on the piston or the spindles of the valves. When the engine was jacketed and gave the same power for short periods, the jacket water removed about 67,000 British thermal units per hour, which would be sufficient to evaporate 108 pounds of water at a temperature of 20 deg. Cent. under atmospheric pressure. Whatever difference there may have been between available heat and amount of water evaporated is accounted for partly by greater radiation loss, and partly by the reduction in flame temperature produced by the steam.

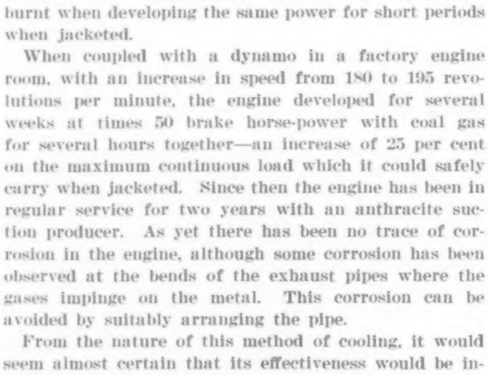
The engine consumed 15 feet of coal gas per brake horse-power hour reckoned at atmospheric temperature and pressure. This is approximately the same as it burnt when developing the same power for short periods when jacketed.

When coupled with a dynamo in a factory engine room, with an increase in speed from 180 to 195 revolutions per minute, the engine developed for several weeks at times 50 brake horse-power with coal gas for several hours together—an increase of 25 per cent on the maximum continuous load which it could safely carry when jacketed. Since then the engine has been in regular service for two years with an anthracite suction producer. As yet there has been no trace of corrosion in the engine, although some corrosion has been observed at the bends of the exhaust pipes where the gases impinge on the metal. This corrosion can be avoided by suitably arranging the pipe.

From the nature of this method of cooling, it would seem almost certain that its effectiveness would be independent of the size of the engine. The method has been applied to an engine of 18½ inches bore, giving 105 brake horse-power and to a 1,000 horse-power Oechelhauser engine of 36 inches bore. The trials of this larger engine proved beyond any question that the largest cylinders now built can be cooled entirely by water injection and that the quantity of water used—about 2.4 pounds per brake horse-power hour—seems almost independent of the size of the engine.

A Stationary Chemical Engine

THE value of carbonic acid gas as a fire extinguishing agent has long been recognized. Statistics show that from thirty to eighty per cent of all fires (in the different cities where the figures were gathered) are extinguished by chemical engines. These figures, of course, relate to those engines which are portable either by hand or on wheels. The latest type of chemical engine is a large stationary outfit intended for use in



The new chemical engine with section of cylinder cut away to show working parts.

office buildings, private houses and isolated plants where proper fire fighting facilities are lacking. This new apparatus was installed in a New York office building last week and demonstrated for representatives of the SCIENTIFIC AMERICAN, the test also being witnessed by several insurance men and city officials.

The accompanying illustration clearly shows the working parts of the engine. The steel tank *T* is lined throughout with lead and is tested to withstand a pressure of 1,100 pounds per square inch. The lead acid bottle *L* is supported below its center on trunions in a hard brass frame *K*. This bottle has a recess on one side, opposite a hole in the frame, through which the piston rod *F* passes to hold the bottle in an upright position until the piston rod is withdrawn. The piston rod, terminating in a flat head which serves as a piston, rests in a bronze cylinder *E* and moves freely therein. This cylinder is connected at the bottom with a brass discharge-pipe *H*, which has a strainer *I* at its lower end to prevent anything but liquids from entering the pipe.

At the top the tank is connected with a discharge pipe *D* which may be coupled with any number of ordinary sprinkler heads *A*, or hand valves *B* with hose *C*, distributed throughout the building. From the top of the cylinder *E* projects a small pipe which terminates in a small gold plate *G*, through which a minute hole is driven. At the top of the tank is a handhole covered with a brass cap *J*, and at the bottom is a valve *M* which serves as a discharge-pipe for waste and as an inlet for the recharging water. Toward the top, on one end, is a connection for carrying a safety valve *R* and an overflow valve *S*.

To charge the engine the piston rod is moved a little to the left, allowing the frame *K* with the bottle *L* to be removed through the handhole. With the overflow *S* open, water is introduced until it overflows at the valve. This allows a certain quantity of water to be placed in the tank each time it is filled. For a tank holding 100 gallons of water about fifty pounds of bicarbonate of soda is introduced and stirred until thoroughly dissolved. The lead bottle is then set in place and filled with about sixteen pounds of sulphuric acid, after which the cap *J* is replaced and firmly screwed down.

It will now be seen that the air space in the engine and that in the pipe system are separated by the water line which fills the cylinder *E* nearly to the top, and by the small gold diaphragm *G* perforated with a minute hole. There is, therefore, no communication between the two bodies of air except through the cylinder, which is normally shut off by the piston, and the diaphragm *G*. By means of any suitable air pump the air is compressed in the pipe line to about ten pounds pressure. This is accomplished by attaching the pump to the tube *U*. The air passes into the tank through the small diaphragm *G*, and when pumping ceases the pressure is equal in the tank and the pipe line.

In case of a fire, the heat of which automatically opens one of the sprinkler heads, or in case a hand-valve is opened, the pressure is lowered in the pipe-line at a much faster rate than in the tank, as a result of which a pressure is induced against the piston in the cylinder *E*, throwing it to the left and releasing the lead bottle containing the acid. The acid is immediately spilled into the soda solution and the resulting reaction causes a gas pressure of 125 to 150 pounds per square inch. This forces the water up through the pipe *H*, through the cylinder *E* and into the pipe line.

A pressure gage *N* is connected with a battery *O* and a buzzer *P* in case the charging pressure should accidentally be reduced to such a low point that it would be likely to fail in case of fire. The buzzer may also be set to sound a large gong *Q* if the pressure should rise abnormally while the apparatus is in use, or it may be connected with a regular fire alarm system.

In the demonstration mentioned the tank was placed on the top floor of a six-story building and connected with a system of sprinkler heads and hand valves in the basement. From the time the water was turned on at one of these hand valves until it reached the outlet of the hose, a period of only six seconds elapsed.

The Area of Canada

IN an article on mapping the world, published in the SCIENTIFIC AMERICAN of July 26th, we stated that the distortion produced by the Mercator projection gives one "the notion that Canada is twice the size of the United States. . . . As a matter of fact the area of Canada is less than that of the United States." We should have said that the area of Canada is but little more than that of the United States. Canada has 3,729,665 square miles as against 3,026,789 of continental United States without Alaska.

An Interurban Airship Line.—It is stated that passenger airship service is to be established in England by a company which will be capitalized at $1,250,000. The airships are to travel from London to Brighton, Manchester, Birmingham, and Paris, among other places.

Pedagogical Laboratories

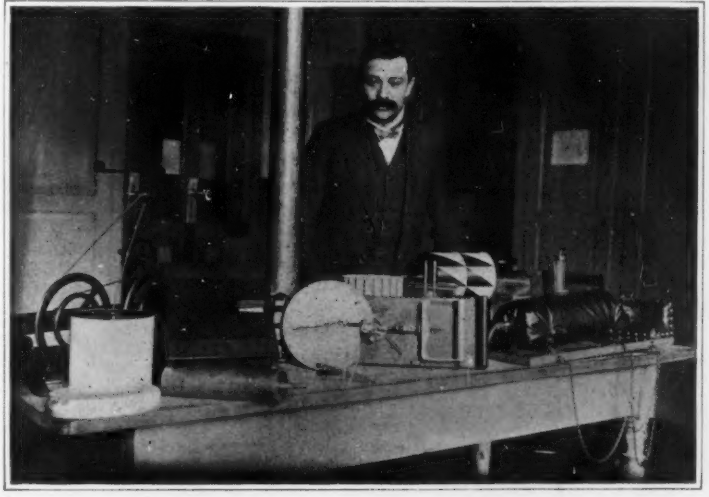
How Children are Studied in a Russian Laboratory from Their Birth Until Their Twenty-first Year

By Dr. P. R. Radosavljevich, New York University

[*TO-DAY nobody will deny that anatomical rooms and physiological laboratories are the foundations of the science and art of medicine; that physical laboratories are the basis of civil and electrical engineering; that psychological laboratories and the psychological clinics are the cornerstones of the science of the human and animal mind. But we are only beginning to see how education is developing on the basis of the accurately determined methods and carefully established principles of experimental pedagogy. Indeed, to-day every sane educator feels a crying need for the scientific investigation of the whole field of educational problems. In this article a pupil of Prof. Meumann's explains how this need for scientific investigation is being met.*—EDITOR.]

A corner in the Zürich laboratory showing models used in teaching anatomy and physiology of child's central and sensory nervous system.

Apparatus of Zürich laboratory for studying pupil's association and reaction.



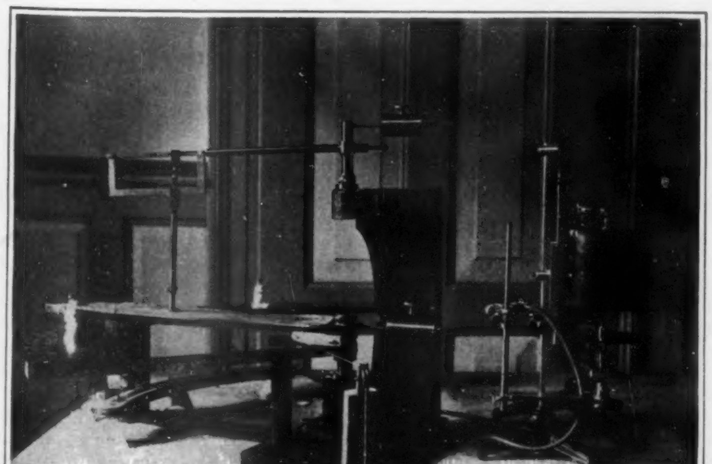
Apparatus of Zürich laboratory for studying pupil's memory, perception, emotional phenomena, etc.

In order to place education on a sound scientific basis we need: (1) *Pedagogical laboratories*, which ought to be the real *sancta* of all true educators who would know the pedagogical truth and understand the real workings of the normal mind of school children and the nature and the postulates of school educational reforms; (2) *Pedagogical clinics*, the function of which should be to discover and cause to be remedied, as far as possible, physical defects and communicable diseases that might interfere with efficient school work of pupils; (3) *Experimental schools*, the purpose of which is (*a*) to find out by experiment *whether*, *how*, and *where* the school educational problems may be worked out, and (*b*) to save time, money, and energy of other people in performing similar elaborate experiments which, of course, require most favorable conditions, especially unhampered work with all the needed resources at hand, in order that results may be reached, both freely and securely, and not by mere subjective discussion and one-sided theorizing.

We have no real, scientific experimental schools and pedagogical clinics. The few attempts made in this direction were quasi-scientific undertakings of private individuals (Dewey, Reddie, Lietz, Frey, Tolstoy, Venzel, Ferrero, Montessori, etc.), who were willing to reform the present school education, but had no necessary means for such a big task. We have only a few pedagogical and psychological laboratories plus their outgrowths as scientific pedagogical periodicals, series of monographs, associations, societies, clubs, congresses, institutes and academic lectures. Germany leads in this field. She has about thirty scientific pedagogical periodicals dealing with the problems of experimental pedagogy, about ten different series of scientific pedagogical monographs, about 30 associations for the study of school children, etc. Next to Germany comes Switzerland, then Belgium, Holland, France, Russia, Italy, Sweden, Austro-Hungary. The majority of German and other European and American psychological institutions are more or less engaged in some pedagogical investigations with special reference to the psychological basis of it.

The first laboratory which devoted its energy to real pedagogical experiments is Meumann's Laboratory in Zürich. Meumann's residence in Zürich (1897 to 1905) signaled the birth of experimental pedagogy. His laboratory soon became the main station of scientific pedagogical research, a Mecca for many foreign students who wanted to get pedagogical facts and were willing to labor in order to observe the real educational conditions. Later he founded similar laboratories in Königsberg (1906), Münster (1907), Halle (1909), and Leipzig (1910). In Hamburg he has his latest laboratory, and in that city he is organizing the first *International Institute for the Study of School Children*. It is a hopeful day for education that a man like Prof. Meumann, himself a master in experimental psychology and philosophy, turned to the practical problems of pupil's development and school instruction. He combines in a very happy and unusual way the different qualifications of a good observer of children and pupils. He has the very first conditions for success (1) a loving interest and the clear sympathetic insight which grows out of this, and (2) he never allows his sentiment to get the better of him, looking at the child from an impartial and unbiased pedagogical point of view. His laboratories were, therefore, always filled with earnest students of all nationalities (Messmer, Ebert, Magneff, Zoneff, Smith, Pentschew, Wintelер, Ziegler, Engelsperger, Abramoff, Mayer, Schmidt, Pfeiffer, Eckhardt, Karrenberg, Albion, Goddard, Starbuck, Hoesch-Ernst, Borst-Dürr, Kelchner, Segal, Gineff, Rakitsch, Chubrovich, etc.), and his lectures were attended by as many as one thousand students.

Meumann's laboratories and institutes (1) collect anthropometric and psychophysical data for the purpose of establishing norms and for ascertaining such relationships as may be of service to school education; (2) apply precise psychological apparatus and instruments, and accurate scientific methods to scientific school educational problems, particularly methods of hygiene teaching and economy and technique of learning; (3) examine school children individually and collectively with a view to advising as to their school



Apparatus of Zürich laboratory for studying arm-movements in children.

Apparatus of Zürich laboratory for studying child's reading and visual perception.

educational management, and (4) give practical and theoretical instruction in experimental pedagogy.

Pedagogical investigations are carried out also in many psychological laboratories and institutes.

Another type of pedagogical laboratory is remarkable and is the first of its kind in the world. It is the *Psycho-Pedological Institute* in St. Petersburg. This institute was founded in 1909, by the generous gift of a great Russian philanthropist (V. T. Simin), who gave to the institute a beautiful "Internat for the Study of Man as a Subject of Education," and also 52,000 rubles. The director of this institution is the famous Russian biologist, V. M. Bechtereff, president of the Psycho-Neurological Institute (opened on February 3rd, 1908), founder of the first Criminological Institute of Russia (St. Petersburg, 1908), and one of the greatest scientists in Russia. The plan of the psycho-pedological institution is to provide for 10 to 15 beds to study the mentality of human beings as subjects of education. Each subject is studied and educated from birth up to 21 years of age. The first child who entered this institute was a baby boy, named Seryoja Parinkin, who is under constant care and observation of two physicians (Drs. K. E. Livshchich and T. P. Spirtoff), and three nurses.

The programme of the studies of these babies is too long to present here. We may mention, however, that it includes not only the problems of the present, but also those of the past of the child, i. e., his hereditary traits and his prenatal life. Here they study carefully the child's organism with all its function, and the dependence of the organs upon environment. The child's temperature is noted every day as well as its pulse, its breathing, and its nourishment. From time to time the child's weight, body proportions, teething and various discomforts (injuries, sickness, etc.) are recorded. The whole development of the sense organs is studied. All these observations will give the most precious practical conclusions in regard to the first days of a child's psycho-physical life, the first steps of his bodily growth, which is closely connected with the mental growth. In addition to that a series of very interesting scientific and practical questions are studied, viz., habit formation in children, natural (native) and artificial (due to exercise only) movements, the child's relation to conscious and unconscious objects, his relation to his new acquaintances and friends, his fears, etc.

Such an objective, patient and constant individual study will be of immense value to pedagogy, physiology and psychology of the child. The St. Petersburg institution should be a great aid toward making good pupils and good teachers. Logically, it does seem that we must know by experiment, before we can teach, or before we can show others how to teach school children. Curiously enough, we have thousands of normal schools, but are just beginning to talk about the need of the kind of school that should precede the normal school. Still we ought to be content that the old school method, founded upon a rigid faith in the book and traditional processes, is loosing its ground almost daily.

The Other Side of War

BY this caption Dr. E. Helme, writing in *Le Temps*, means to indicate the rougher side with which those individuals come into painful contact who feel within their own skins the effects of modern weapons. To the question: Will war be more murderous in the future? this expert answers with an unhesitating affirmative. Wars, it is true, instead of lasting a hundred, thirty, or seven years, as in bygone days, now last only a few months. But this, he says, simply means that the blows are heavier, and the combatants are sooner exhausted. The Russo-Japanese war lasted only eighteen months, but the battle of Sha Ho, in Manchuria, lasted twelve days. Thus, although the number of killed and wounded per day in the actual fighting of the Franco-German war may have been greater, the losses in battle in the Manchurian campaign were much greater in the aggregate. The truly terrible fact, however, is the increasing proportion of mortal to non-mortal wounds: In the Franco-German war of 1870-71, the victorious army lost ten men killed to every 58 wounded; in 1904-05 there were ten Japanese killed to every 37 wounded.

Coming to the explanation of these facts, Dr. Helme dismisses as "a troublesome legend" the story that modern bullets, being smaller and moving more rapidly, inflict less serious wounds. Really slight wounds, he maintains, heal more quickly and more thoroughly nowadays than formerly; but the severe wounds are no less severe and much more frequent. To illustrate this the writer considers, first, the form and structure of projectiles and then their motions. "The lance *well handled* inflicts severe abdominal wounds," and the Japanese cut-and-thrust bayonet "is terrible;" but the writer's main theme is the effect of projectiles.

First comes the rifle bullet, "but yesterday the Queen Murderess of Battles." The German bullet consists of a core of lead hardened with antimony, covered with a steel jacket. It is none the less efficacious because the jacket often comes off and acts on its own account as a jagged fragment of metal, lacerating the human body. The French bullet, though not jacketed, is no kinder to the enemy. It is longer and sharper-pointed than the German, and is made of a mixture of copper and zinc. Becoming bent by ricochetting, it sometimes enters its victim's body in the shape of a hook; sometimes it "tumbles" in its flight, enters broadside-on, and makes a long, gaping wound. Up to a range of 800 meters these rival horrors are one as bad as the other.

The gravity of the wounds depends on a multitude of conditions. On the rocks of San Juan, where the bullets ricochetted in wonderful fashion, the American surgeons reported frightful injuries. It was the same

Prof. Wladimir Michailovich de Bechtereff.

He was born in 1857 in Wiatka (Russia) and is one of the greatest living Russian scientists, whose works are published in Russian, German, French, and Bohemian.

at Spion Kop, in the Transvaal. It used to be said, optimistically, that a bullet heated by friction in the barrel of the rifle would reach its object asepticized by friction; but this hope has been dispelled by the researches of von Koler, showing that the temperature of the projectile never comes within many degrees of that which is necessary for the destruction of microbes. The cruelty of the modern bullet has been augmented, too, with the increase of its rotation, so that it acts not only as a club, striking a heavy blow, and a perforating point, but also as a gimlet which lacerates the tissues.

But bullets, after all, are mild agents of destruction when compared with up-to-date shells. The shell wounds in the war of 1870 were only 91 per thousand; in the Manchurian campaign they were 176 per thousand; in the Balkan war of 1912 they were four times

Some anthropological instruments which are used in a pedagogical laboratory.

as numerous as in 1870. The shrapnel shell has the advantage (to its employer) of scattering destruction by means of some hundreds of small round bullets as well as the fragments of the shell itself. This "devil's watering-pot," as the Russian soldiers called it, works best within a radius of 10 to 30 meters; at 100 meters its "dewdrops" are still lively enough to penetrate 6 centimeters of pine board; at 300 meters a turban will protect the head from their effects. The tortuous incisions made by shrapnel are particularly difficult to disinfect. But in spite of all this, and though the ear of the most hardened veteran is said never to become accustomed to the death-song of shrapnel overhead, the common shell is really more terrible. Its fragments, brought to a very high temperature by the explosion, "burn the flesh so as to compel cries of agony which only morphine can quiet." Lastly, the large shells of the naval guns "not only cut like razors, but asphyxiate, amputate portions of the body and crush."

Dr. Helme's study of the movement of projectiles and its effects at various ranges, and on various tissues, should be minutely interesting to those who love "the pomp and circumstance of glorious war." Its effects on bones, in particular, are classified as: (1) explosive; (2) comminutive; (3) contusive. The first, resulting when the range is not greater than 500 meters, splinters the bone so thoroughly as to explain the frequent accusations of using explosive bullets which have become a feature of modern war news. The second, proper to the zone of from 500 to 1,200 meters, is distinguished by the danger of bringing with it fragments of soiled clothing, carrying gangrene. These effects are observed only in the main body of the bone; in the spongy extremities there is less harm done, except when the extravasation of blood brings on a diseased condition of the joint.

The effects of projectiles on soft tissues and organs containing liquids has led students of the subject to some highly interesting experiments. A bullet fired at an empty metal vessel makes a small hole both entering and leaving. But a bullet fired at the same kind of vessel filled with water, while it enters through a small hole, as before, leaves through a jagged opening 12 centimeters wide. This very fairly illustrates the effects of a bullet upon, say, a human stomach. The explanation advanced by the experimenter is: "In its passage, the bullet carries with it molecules, which are of very small mass, but move with great rapidity; these, being projected in all directions, have the effect of compressing the inert molecules (of the surrounding medium) and an outburst of the wall of the vessel follows at the egress of the projectile." And so it is that bullet wounds in the stomach, bladder, liver, intestines and head, received at short range, produce veritable explosions of these parts.

The writer concludes his discussion with the consolation, such as it is, that science and humanity appear in a much better light when we consider their achievements for the benefit of the good men who are wounded in their country's service.

A New Wright Hydro-aeroplane

A NEW type of Wright hydro-aeroplane has been designed by Wilbur Wright. In the tests which have been conducted on the Miami River, near Dayton, O. Mr. Wright has already made more than a hundred successful flights. This new machine, which is known as the Wright Model CH, is remarkable for the ease with which it starts and alights. The planes, rudder, motor and drive follow the standard Model C lines. The span is 38 feet, chord 6 feet and the surface area about 440 square feet. The weight empty is 1,160 pounds, including the main float, which alone weighs 240 pounds. The hydroplane unit consists of a single float 6 feet wide, 10 feet long and 10 inches deep, besides a small pontoon which supports the tail. The machine is equipped with a new Wright six-cylinder, 60 horse-power motor, which drives two 8½-foot propellers.

One Starter in the English Coast Flight

THE London *Daily Mail's* $25,000 contest for the circuit of the British coast with an all British hydro-aeroplane, was started on August 16th from Southampton with only one participant, Harry G. Hawker, the winner of the Michelin prize in 1912. Hawker carried a passenger, and made his first landing at Ramsgate, a distance of 144 miles from the starting point, which was covered in 143 minutes. His machine is a biplane equipped with a 100 horse-power motor and with a tractor propeller. The only other entrant remaining on the list of contestants is Frank McClean, who did not reach the starting point in time to begin the flight with Hawker, but who was expected to enter the contest later in the week.

The Retirement of Commissioner Moore

EDWARD B. MOORE, retired from the Patent Office on August 15th, after a service as assistant commissioner and commissioner extending over twelve years, and following service on the examining corp of about eighteen years. Mr. Moore has entered upon the practice of patent law, becoming a member of the firm of Moore & Clark with offices in Washington, D. C., and New York city.

Cleaning Boiler Gages

A GOOD way to clean the deposits or stains from the glass gages on steam boilers is to remove and soak them in the following solution: Water, six ounces; salt, 1 ounce; acetic acid, 1 ounce. After the glass is thoroughly moistened place some baking soda inside and place back in the solution. A gas is evolved that removes the iron or calcium stains in the tube. The solution is harmless to the hands. A cloth drawn through the tube dries it and cleanses remaining spots.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

An Acknowledgment of Indebtedness

To the Editor of the SCIENTIFIC AMERICAN:

In your issue of February 8th there appeared under my name an article entitled "Shall We Build Battle-cruisers?" Since that time, and particularly within the last few days when the question has been the subject of considerable discussion, I have heard quite a little favorable comment on the stand then taken against this type of vessel.

The arguments therein advanced are in no sense original, and for both the arguments and the manner of expressing them I am indebted to former Naval Constructor R. H. M. Robinson.

I would be glad if you would publish this letter in your widely circulated columns. R. D. GATEWOOD,
Naval Constructor, U. S. Navy,
Fleet Naval Constructor.

United States Atlantic Fleet,
U. S. S. Wyoming, Flagship.

A Judicial Decision Involving the Camera Film

A DECISION was recently handed down by Judge Hazel of the United States District Court for the Western District of New York, in the case of the Goodwin Film and Camera Company vs. the Eastman Kodak Company, a decision, which, if sustained on appeal, will be of far-reaching effect.

Roll-holders for films were suggested at a comparatively early period. Their use, however, was restricted. There was a demand for a flexible and rollable film support which could be conveniently carried by the photographer in place of glass. In 1885 such a film was devised and made practicable by Mr. George Eastman. This film was of paper coated with a gelatine bromide which became the negative and which was readily removable from the paper. But there was still a desire for more satisfactory film supports. The paper stripping films were objectionable on account of the not infrequent appearance of the grain of the paper in the picture and on account of the thinness of the film, which made it difficult to handle in the printing operation. In spite of the success attained by the paper films, they were soon displaced by a transparent flexible nitro-cellulose film support upon which the sensitive emulsion was flowed. This film was placed upon the market by the Eastman Company, but Hannibal Goodwin claimed that he was its original inventor.

Goodwin took out a patent in 1898 for a photographic pellicle and process of producing it which was acquired by the Goodwin Film and Camera Company, and which was made the basis of the patent infringement proceeding decided in favor of the complainant by Judge Hazel. In his patent, Goodwin states that a solution of nitro-cellulose (not the commercial compound known as celluloid dissolved in alcohol or ether) dissolved in nitro-benzol or other non-hydrous and non-hygroscopic solvents, such as may be employed in producing celluloid, as distinguished from collodion and diluted in alcohol or other hydrous and hydroscopic diluent, is flowed over glass. A smooth, transparent, impermeable film, capable of being subjected to photographic fluids without being affected thereby is obtained. The solution obtained by dissolving the nitro-cellulose in this non-hygroscopic solvent, is diluted with alcohol or some other diluent, which, like alcohol, serves to dilute or expand the volume of the dissolved nitro-cellulose and increase its fluidity, and which may be and ordinarily is hygroscope, miscible with water and highly volatile. This diluted solution is then applied to a smooth and hard surface, from which it may be stripped when dry.

Because of the high volatility of certain elements contained in the solvents, they evaporated rapidly, leaving the pellicle more or less fluid, until the high boiling elements, which evaporate more slowly were also evaporated, whereupon it became hard, transparent, and non-porous, and being without oil or greasiness, resisted the injurious effects of the photographic emulsion. The desired result was achieved principally through the high boiling quality of the solvents and their non-hydrous and non-hygroscopic character.

There was considerable argument in the Patent Office, after Goodwin's application for patent was filed, in an effort to persuade the primary examiner that a patent for process and product should be granted. The application was finally rejected in 1898. An appeal was taken to the Board of Examiners in Chief, and the decision of the Board favored the issuing of the patent, the Board substantially adopting the view that the prior art did not disclose means for successfully producing a photographic film of the kind specified in the Goodwin patent and claims.

Long before Goodwin's day chemists were aware of the fact that nitro-benzol and amyl acetate possessed non-hydrous and non-hygroscopic properties, and classed them as solvents of nitro-cellulose, gun cotton and pyroxolene. Goodwin, however, drew a sharp distinction between his solution and the solutions of collodion or celluloid, which was composed of nitro-cellulose and camphor ordinarily dissolved in ether or alcohol, and expressly disclaimed the latter, all the while claiming an improvement in the specific combination of nitro-cellulose dissolved in nitro-benzol or other non-hydrous or non-hygroscopic solvents, and diluted in alcohol or its equivalent. In its decision the court adopts Goodwin's contention.

During the prosecution of the case in the Patent Office, Goodwin became involved in an interference with Reichenbach. Reichenbach, who had no knowledge at the time of his invention of Goodwin's application, described his process as depositing or spreading a fluid solution of nitro-cellulose and camphor upon a suitable surface. He disclaimed the issue of the interference and canceled his broad claims. Subsequently letters patent were granted to Reichenbach, covering his specific process, namely a solution of nitro-cellulose and camphor in methyl or wood alcohol with a quantity of fusel oil and amyl acetate added. Goodwin had never claimed camphor as a solvent, but on account of the resemblance of his solution to celluloid, which contains camphor, the examiner decided that interference with Reichenbach was proper. Presuming that his broad claim had been allowed, Goodwin practically conceded priority to Reichenbach's specific process, and consequently his successor in title was estopped from asserting infringement by film supports made in strict accordance with the Reichenbach formula. After its issuance the Reichenbach patent was cited as anticipatory of Goodwin's broad claim, until on appeal to the Commissioner of Patents, it was held that such a patent being later than Goodwin's application, it was not a proper citation.

Meanwhile, however, the Eastman Company marketed film supports made in accordance with the Reichenbach process, and these supports were regarded as solving the problem and were used largely in place of glass. The court held that "in departing from the specific formula of its own patent, the defendent utilized the equivalent of the method specified by Goodwin in his patent and achieved the same result. The Reichenbach solution was concededly prepared with approximately 60 per cent of camphor, which, according to the proofs, was decreased from time to time to about 14 per cent relative to about 22 per cent of nitro-cellulose, a decrease in the quantity of camphor sufficient to overcome objections." These objections were the cockling and puckering of films made in accordance with Reichenbach's process. The court decided that the two processes "are not distinguishable in principle." "The improvement in the film support is due to the combination of equivalent high and low boilers, and therefore the departure in its production is merely within the scope of the claims."

If the Eastman Company should lose this case on appeal, the present owners of the Goodwin patent may find themselves entitled to collect damages involving millions of dollars.

What Are the Ten Greatest Inventions of Our Time, and Why?

A Prize Article Contest Open to All Scientific American Readers

THE November Magazine Number of the SCIENTIFIC AMERICAN is to be devoted in part to a review of the great inventions of our time. Because a large number of SCIENTIFIC AMERICAN readers are either inventors or users of inventions, it seems to the Editors that their judgment of the inventions produced in our time which deserve to be called the greatest, their appraisal of the relative importance of the paramount technical achievements of our day, would be of peculiar value and interest. Therefore, it has been decided to leave the entire subject to them.

The publishers of the SCIENTIFIC AMERICAN offer three prizes of $150, $100 and $50, respectively, for the three best articles on the topic, "What Are the Ten Greatest Inventions of Our Time, and Why?"

Contestants for the prize must observe the following rules:

1. Each article must discuss and answer the following three questions:

a. What, in your estimation, are the ten greatest inventions produced within the last twenty-five years?

b. What are your reasons for this selection? Justify your selection in each case.

c. To what person or persons is the greatest credit due in the developing and perfecting of each invention which you have selected?

2. The entire subject must be covered in a typewritten article not exceeding 2,500 words in length, and must be treated as simply, lucidly and non-technically as possible.

3. In deciding what are the ten greatest inventions of our time, the contestants are limited to machines, devices and discoveries commercially introduced in the last twenty-five years.

4. Since the SCIENTIFIC AMERICAN is "the weekly journal of practical information," and its readers practical business men and inventors, the articles submitted should deal only with *patentable* inventions and discoveries.

5. In order to guide the contestant in deciding what is a great pioneer invention of our time, it is suggested that practical success and general usefulness to mankind be used as a test. A modern discovery may have been suggested long ago and its underlying theory even worked out mathematically, as in the case of wireless telegraphy, but nevertheless it falls within "our time," if it has been made generally accessible and useful within the last twenty-five years. But commercial success should not be the sole criterion. The flying machine has not yet added millions to the national wealth; but, for all that, it is a great invention of our time. Mere improvements on well-known and successful devices are not to be numbered among the great inventions of our time. Because an invention was first patented more than twenty-five years ago it is not necessarily debarred. The date of commercial introduction not the date of the patent governs. The invention, moreover, need not have been actually patented, but its subject matter must be of a patentable nature. Patentability is merely a test of commercial practicability.

6. Contestants must not disclose their identity. Each article must be signed with an assumed name and must be accompanied with a sealed envelope, on which the assumed name is written, and in which the real name and address of the author is contained.

7. Contestants must address their articles, accompanied by the envelopes containing their real names, to "The Invention Contest Editor of the SCIENTIFIC AMERICAN, 361 Broadway, New York city."

8. The articles will be passed upon by a Board of Judges, whose names will be announced in a future issue of the SCIENTIFIC AMERICAN.

9. The Board of Judges will receive only the articles submitted; the envelopes containing the true names and addresses of the authors will remain in the possession of the Editors of the SCIENTIFIC AMERICAN. When the judges have made their decision, the Editors will open the envelopes of the winning contestants and notify them of their success.

10. The decision of the judges will be announced in the SCIENTIFIC AMERICAN of November 1st, 1913. The prize-winning articles will be published in the order of merit in consecutive issues of the SCIENTIFIC AMERICAN, beginning with the issue of November 1st, 1913.

11. The Editors of the SCIENTIFIC AMERICAN reserve the right to publish in the SCIENTIFIC AMERICAN or the SCIENTIFIC AMERICAN SUPPLEMENT articles which have not been awarded prizes, but which are deemed worthy of honorable mention.

12. While contestants are not required to supply pictures with their articles, illustrations will be welcomed. If drawings are submitted, they need not be elaborate; the staff artists of the SCIENTIFIC AMERICAN will work them up for reproduction, provided the material supplied is intelligible. Do not send pictures torn from books and periodicals; they cannot always be reproduced satisfactorily, and their unauthorized reproduction may constitute a copyright infringement. If photographs marked "copyright" are sent, they should be accompanied with the copyright owner's written permission for their reproduction.

13. Members of the staff of Munn & Company, Incorporated, publishers of the SCIENTIFIC AMERICAN, and of Munn & Company, solicitors of patents, are excluded from the contest.

14. All articles will be received up to 5 P. M., September 1st, 1913.

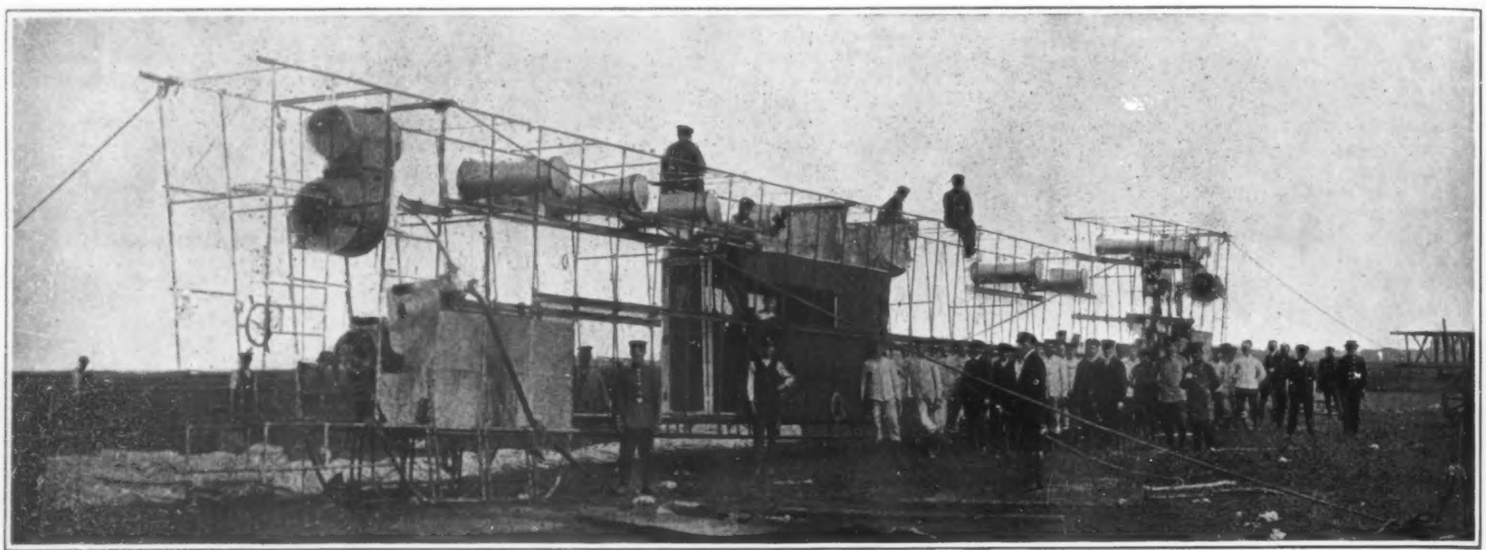
The Current Supplement

IN this week's issue of our SUPPLEMENT Prof. Lawrence Martin of the University of Wisconsin, who has been leader of several Alaskan expeditions, writes on glaciers and the effect of their movements upon international boundaries.—H. M. Nichols contributes an article on the installation and care of storage batteries. —Many of our readers will take a personal interest in a discussion of the advantages of electric light as compared with gas for motorcycles.—Robert F. Pierce reports on the preparation of a source of artificial daylight by the use of suitably chosen light filters. —Lieutenant Colonel J. E. Kuhn contributes the first instalment, dealing with traffic by land, of a series of articles entitled "Some Aspects of the Subject of Transportation."—In last week's issue we had an excellent review of our present knowledge of the blood as it appears in health. H. G. Plimmer tells us something this week about the blood in disease.

Dissecting a Military Dirigible Airship

An Interesting Experiment With the New "V1"

By Dr. Alfred Gradenwitz



AN interesting operation was recently performed, when the German dirigible "V1" was taken apart in accordance with military regulations, thus bearing out the designer's claims that the ship is a "knock-down" craft.

The aerial cruiser, which in appearance resembles a rigid airship of the Zeppelin type, had landed in the vicinity of Jülich. Her crew, assisted by twelve men, began on the same evening the detaching of the keel and the evacuation of the gas envelope. On the following day, the keel, consisting of steel tubes, was unscrewed, the various sections being loaded on farmer's wagons, which by the following noon reached the Düsseldorf airship shed. The distance covered was 33 miles. After a day's rest, the keel was replaced by the same crew. The whole performance spoke well for the remarkable success of this new military airship type.

The "V1" has been built according to the Veeh patents and is of the semi-rigid type, combining, it is claimed, the individual advantages of the rigid and non-rigid systems and avoiding their draw-backs. The gas capacity is 8,500 cubic meters; the length, about 80 meters; and the maximum diameter, 13 meters. The main distinctive feature is a rigid keel frame constituting a covered gangway immediately below the envelope. Easy access to all parts of the craft is therefore secured while under way, and at the same time an artificial stiffening is provided which does away with the necessity of any additional cars. This frame, which forms, as it were, the breastbone of the whole airship, not only permits the load to be distributed as desired (arranging e. g., the ballast and fuel in small tanks in any part of the keel), but insures an advantageous arrangement of the steering mechanism, far away from the center of rotation at the stern, without overloading the latter.

The envelope is a single large gas-compartment and is fitted with two auxiliary ballonets intended primarily to maintain the proper gas tension, while serving as well, in cases of emergency, for changing the altitude. The shape of the gas bag is preserved in the usual way by two self-contained centrifugal blowers, means being provided for each ventilator fan to be driven from one of the two main motors, and to feed both the fore and aft ballonets. The blowers and gas bags are controlled by the pilot. Hand operation has likewise been provided for.

The "V1" in flight.

Normal steering in a vertical direction is effected by means of planes arranged like Venetian blinds. The keel is strong enough to carry without any support the weight of all planes, with an ample margin of safety. The two points are able to stand not only the weight of the ballast there installed (tow rope, etc.), but in the event of the balloon being torn, the wind pressure on the stabilizing and rudder surfaces. Actual load tests have shown the extremely high bending strength of the whole keel. No account need therefore be taken of the strain on the envelope in distributing the loads, and the main lines of the rigging are submitted to equal pulls in a vertical direction only. Again, the suspension of the keel is such as to distribute the weight uniformly over the whole balloon envelope.

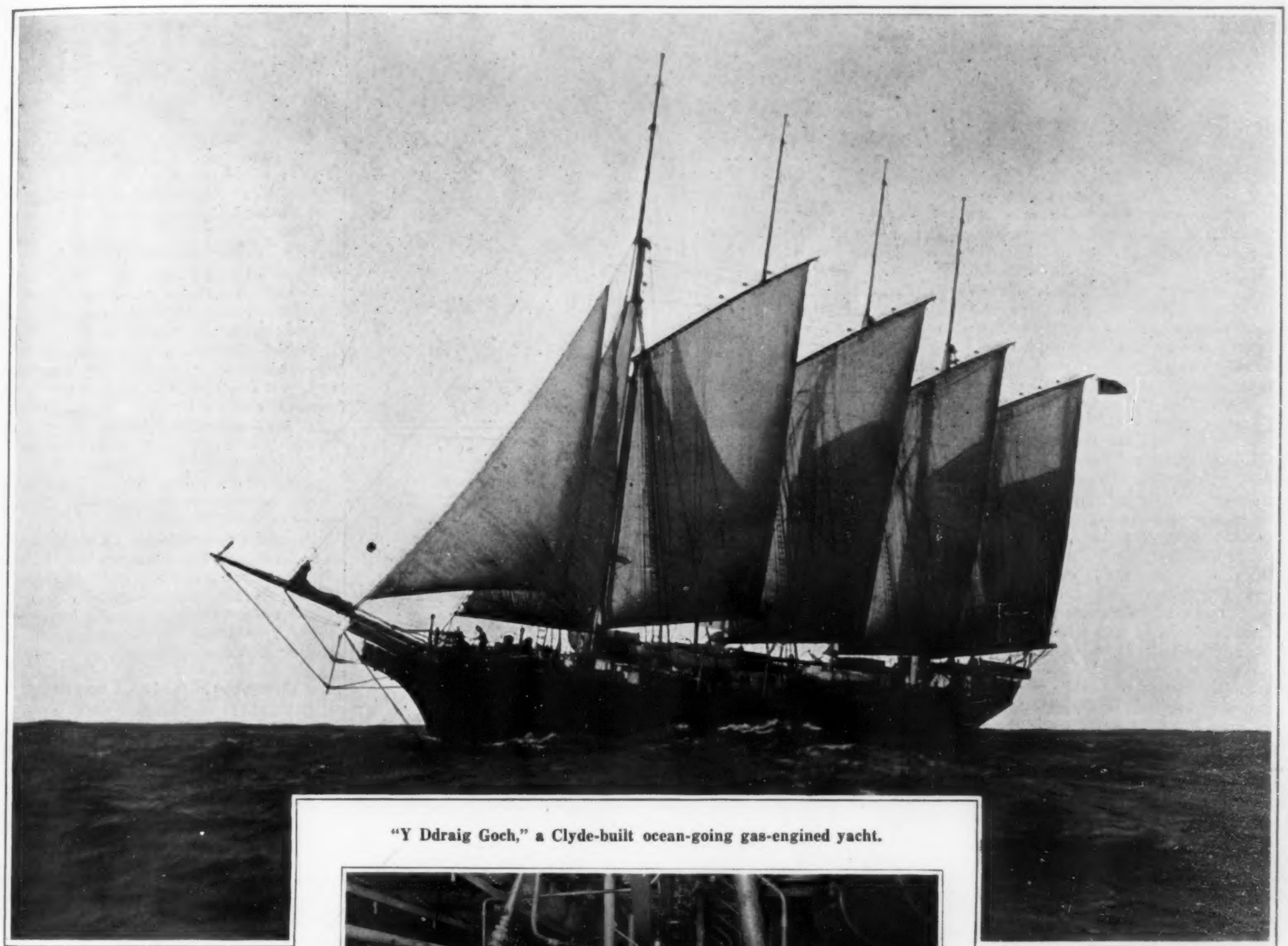
Carrying the keel-frame on farmers' wagons.

The engine plant comprises two entirely separate and self-contained four-cylinder sets each of 130 horse-power. Rubber ropes are employed in the transmission. It may be said that rubber rope transmission, as used for a number of years with most satisfactory results, has the advantage over hemp rope transmission of being absolutely weather-proof and of undergoing no variation in tension by moisture. A large safety factor has been obtained in connection with this propeller drive, triple ropes being provided so that even should two be torn, the corresponding propeller will not be disabled.

The propellers are of wood, 4.5 meters in diameter, and revolve at the rate of 350 revolutions per minute. They are supported in ball-bearings in lateral brackets on the keel frame, as high as possible, e. g., as close as possible to the center of resistance.

Air Strength of Russia

ACCORDING to the London *Times* in the Duma on June 24 the chief of the general staff, replying to numerous inquiries, stated that in the course of a year, since a department for aviation had existed in the ministry, the number of aircraft had increased tenfold. The ministry would not rest until a flying detachment had been established in every army corps, to carry out scouting operations in time of war. The ministry had seized the first opportunity to double the number of dirigible balloons and had acquired airships, of the kind known as aerial "dreadnoughts," of the newest type. These were fitted with the latest improvements, and were provided with machine-guns, bomb-throwers, and telegraphic apparatus. It was true that Germany had 11 dirigibles, but only 8 of these came up to the standard of the great Russian dirigibles. All six of Russia's dirigibles could cope with Germany's dirigibles, and it must be taken into consideration that whereas Germany had two military frontiers Russia had but one.

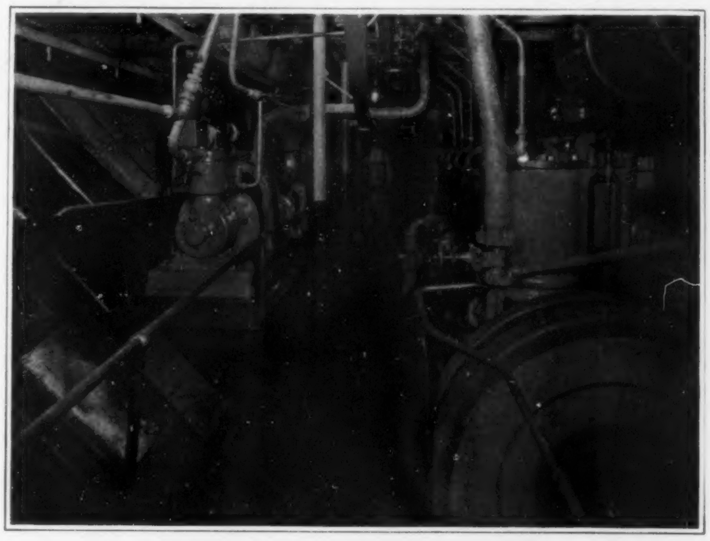


"Y Ddraig Goch," a Clyde-built ocean-going gas-engined yacht.

Gas Engine Yacht

By Robert MacIntyre

THE vessel pictured in this article, is in several respects unique. She is "Y Ddraig Goch," which is Welsh for "The Red Dragon," and was built on the Clyde from designs by Mr. William Gray, a well-known British naval architect, for Mr. Godfrey Williams of Aberpergwm. Mr. Williams is a wealthy Welshman who has inherited from a long line of bearers of his name lands in South Wales which are rich in coal, especially anthracite. His hobby is ocean cruising, and he has in his day owned more than one large yacht. None of these quite pleased him, however, so he set about the formulation of his requirements and handed the result over to Mr. Gray to be embodied in an ocean-going yacht. "Y Ddraig Goch" is the yacht.



The engine room of the "Y Ddraig Goch," showing the main propelling and dynamo-driving engines.

Rigged as a four-masted fore and aft schooner spreading some 23,000 square feet of canvas, excluding balloon sails, she is 200 feet long, 38 feet broad, by 21 feet 6 inches deep, displaces 1,400 tons, and measures 1,000 tons gross. The accommodation for the owner and his friends is artistically decorated and elegantly furnished, the furniture consisting of reproductions by a London West End firm, of existing examples of the period of William and Mary. Most of it is in walnut. The dining room is in white enamel with panels depicting ancient ships. The drawing room is framed in walnut. Elsewhere, except in the chart room, white is preferred, an excellent effect being obtained in the children's room by adorning the panels with delicately traced pictures in pale blue of hunting scenes in olden times.

With all this elegance of accommodation

Writing room of the "Y Ddraig Goch," finished in white enamel.

Drawing room of the "Y Ddraig Goch," framed in walnut.

"Y Ddraig Goch" combines the structural strength of a mercantile ship. She has been built, indeed, to Lloyd's highest class for sailing ships, and in excess of the requirements, her main deck being for the greater part of its length watertight. She is the largest motor auxiliary yacht ever built in European waters, and the first of any size to be propelled by means of a gas engine. The power for her motors is produced on board from anthracite coal, of which she can carry in watertight bunkers sufficient to take her round the world under power alone. As the fuel is used the bunkers are utilized for water ballast.

The main propelling engine is a six-cylinder type of 160 brake horse-power, and it drives a feathering propeller through a clutch. A less powerful four-cylinder engine of the same make drives a dynamo which provides the power for lighting the ship and working the deck machinery. In order that there may be no need to use this smaller engine at night, a secondary battery has been fitted, which is equal to the work of the whole of the ship's plant for twelve hours. The main engine can be disconnected from the propeller shaft and used to drive an auxiliary dynamo.

The vessel is heated and ventilated by means of thermotanks, which are, in this instance, and for the first time in a yacht, adapted to the use of sea water in tropical climates. The temperature on board can never be more than 2 or 3 degrees in excess of that of the sea water. Nothing which the owner's experience of seafaring could suggest has been left unprovided, down to roller reefing gear on the booms. The yacht, which is now cruising in West Indian waters, has proved herself to possess fine weatherly qualities, and her gas plant has so far given excellent results.

Bird Castle Built by a Blind Man

THE accompanying photograph pictures the work of a man deprived of eyesight who has devoted his life and means to the protection of insect-destroying birds. Solely through the sense of touch he has constructed a bird house of 102 rooms to provide a home for the purple martin. Mr. John T. Timmons, the builder of this bird castle, is an authority on bird houses, having erected many homes for his feathered friends. He has also written many articles of interest on the purple martin and other insect destroyers.

Detroit's Novel Pay Car

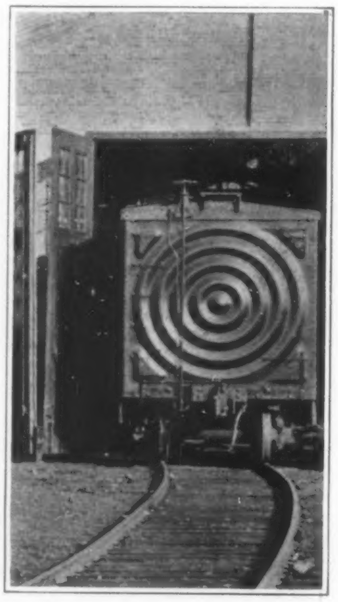
BECAUSE of the robbery of the patrolmen who were formerly sent with the pay envelopes for the city laborers, the city of Detroit, Mich., has forestalled further hold-ups by installing a pay car of unique design. It is an automobile, strongly built with inclosed body and barred windows. The entrance which is in front is guarded by two armed patrolmen, one of whom drives the car as well. The interior is conveniently arranged for paying off the men, and the cashier sits at a swivel chair with his compartments full of indexed envelopes on either side, and a small paying ledge in front where the men line up to receive their wages. The car is the first of its kind, but will probably not be the last, as it seems to meet a public need.

Benzine as an Aid to Red Blood

ACCORDING to the observations of Barker and at a later date those made by Selling, benzine has a marked action upon the corpuscles of the blood; in fact, it is found to destroy the white corpuscles without much action on the red. These results led Von Korangi to use benzine in cases where the blood contains a greater number of white corpuscles than the normal amount, this causing the disease known as leucemia, analogous to anemia. His first researches, made in 1912, gave good results and confirmed the previous authors' observations. Since that time Aubertin and Parvu found a lessening of the white corpuscles and an increase in the number of red corpuscles due to small doses of benzine in the case of two patients, and this method may be called upon to replace radium treatment which was hitherto the only one available. Kiraylfi found that the number of white corpuscles fell from 363,000 to 9,600 in seven weeks, and in another case from 131,000 to 7,200 in 15 days. Not more than a few drops of benzine per day should be administered in order to avoid poisoning by this substance.

Collecting cream for the college dairy.

A 102-room bird house constructed by a blind man.



Car end of a single piece of pressed steel.

Paying off laborers from a city pay car.

Interior of the pay car. Note the strongly barred windows.

A Motorcycle Milkman

AS IS well known, thousands of students in colleges and universities earn enough money by working at different tasks to defray part or all of their expenses. There is a wide variety in the work done by the students and sometimes a good deal of originality is displayed in discovering a well-paying job. A student at the Kansas State Agricultural College who owns a motorcycle has found that he can make use of the machine in co-operation with the college dairy, doing a milk and creamery business. Besides delivering milk and cream to customers in town, he makes runs into the country on his motorcycle, going out as far as twenty miles to purchase cream from the farmers and bring it back to the college. The milk and cream is carried in cans hung over the rear wheel of the motorcycle, as shown in the accompanying illustration.

One-piece Steel-end Freight Car

STEEL is rapidly displacing wood in the construction of railroad cars—not only in passenger cars where the safety of the passenger is an important consideration, but in freight cars as well. The accompanying illustration shows a freight car, the entire end of which is made of a single piece of steel pressed with concentric annular corrugations, making a very strong and durable end wall. No posts, braces or rivets are required in this end piece. Not only is it stronger than a built up end would be, but it keeps the car in alignment and allows, furthermore, an additional foot of space within the car. The end piece is applicable to any class of car old or new, as it can be made in different sizes. It is fastened to the rest of the car body by means of bolts or rivets which pass through flanges at the edges.

The Origin of Screws and Gears

FREMONT, in his recent work on the origin of screws and gears, brings out some interesting points on this subject. The Greeks are supposed to have invented the screw, but the two Roman authors, Pliny and Vitruvius, give the most ancient record we possess on the subject, although it must certainly have been known long before their time. Certain authors think that the idea of the screw comes from observation of a natural object of helical form such as a gasteropod mollusk, but Fremont thinks that it arises from forms in movement. For instance, when an edible snail is drawn out of its shell, we have the idea of screw and nut. Unfortunately the ancient records throw scarcely any light on the subject. The principle of the screw seems to have been but little used until the middle ages, when it was first applied for wine or cider presses.

During the first centuries of our era bolt and nut was replaced by threadless bolts having a hole containing a conical pin, so that driving in the pin increased the pressure; such bolts had holes spaced along for adapting to different thicknesses of material. The Egyptian *noria* may account for the origin of gearing. This seems to have been a wheel working on a horizontal shaft and operated by a crank. Along the wheel surface were cleats for retaining the bucket chain which descended into the well, and in this way the buckets were raised, one after the other, full of water. But to drive the *noria* by an animal makes a vertical shaft necessary, and an ingenious person may have extended the cleats on one side in order to make them engage with a sort of lantern-shaped pinion placed on a vertical shaft.

Scorpions in battle for possession of a captured cockroach.

How Insects Fight

Stings, Mandibles, Horns and Poisons in Warfare

By Percy Collins

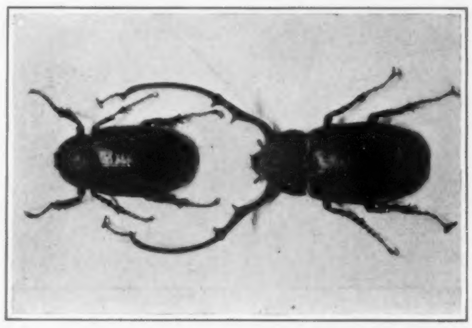
The grotesque rear-horses or mantids in combat. About one half natural size.

MOST animals fight when occasion demands, and insects are by no means exceptions to this rule. Indeed, many insects must be regarded as accomplished warriors, equipped with weapons of uncommon efficacy, and versed in all the strategic arts. Those who have paid attention to the warfare of insects are aware that their contests may usually be classed under one of three headings: they are either (1) purely defensive, or (2) an outcome of the courtship instinct, or (3) definitely aggressive. Certain insects, however, appear to labor under the influence of a veritable mania for battle. Among these are the well-known rear-horses, or mantids, whose fore legs are so remarkably modified to act as raptorial implements. With these terrible limbs, which are hinged and spiked in such a manner as to combine the attributes of the flail and the skark's teeth sword of the Pacific Islanders, rear-horses capture and hold their prey; but they are also used as weapons of offence and defence. It is said that two rear-horses scarcely ever come face to face without fighting. Moreover, the contest is not merely a display of skill, but a duel to death. Sooner or later one of the combatants gains a momentary advantage, and seizes its opponent. This puts an end to the battle; for the victor never releases his grip, but begins at once to make a meal of his opponent. Nor are these affairs confined to the members of one sex. The female rear-horse often, if not usually, tires of her accepted suitor; and when this happens she rushes upon him with menace. The male attempts to defend himself, but as he is smaller and less robust than his spouse he is generally defeated. Subsequently, the female calmly devours her quondam mate. Beyond these conflicts for prey the mantids are harmless.

Among the purely defensive appliances of insects, none is more interesting than that possessed by the so-called bombardier beetles of the genus *Brachinus*. These insects are carnivorous, and destroy small Arthropods of various kinds; but they are themselves preyed upon by larger beetles of their own family. When one of the hereditary enemies gives chase, the bombardier runs rapidly away. If speed were its only chance of escape, however, it would stand but a poor chance. But nature has endowed it with a remarkable defensive equipment. It is able to eject an acid fluid from glands situated at the tip of its abdomen. This fluid vaporizes immediately on contact with the air, and looks like a tiny puff of smoke, while at the same time a distinct report is heard, reminding one of a miniature cannon. The beetle is able to repeat this discharge several times in rapid succession before its store of ammunition becomes exhausted. In this way the little artilleryman is able to disconcert its would-be captor, and very often contrives to rush into a cranny, or under a stone, where the enemy cannot follow. The acid discharge of certain large South American bombardiers is extremely caustic. It burns and stains the human skin, leaving marks which remain for a considerable time.

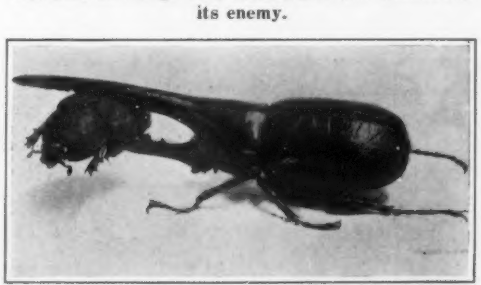
The most formidable weapon possessed by insects is the poison sting. It is only found among the higher Hymenoptera (i. e., insects of the bee and wasp kind), and is confined to the female sex, being, in fact, a modification of the ovipositor, or egg-laying apparatus. The sting is not a hollow perforated needle—like the fang of a snake, but a complex organ made up of several parts working in conjunction. There is a grooved and pointed shaft, along which slide two darts, more or less barbed. The shaft is first used to open a wound. Then the darts are plunged alternately into the tissues, while an acid secretion flows down from the poison-sac. Like bees and wasps, some species of ants are equipped with stings, but others lack these weapons. The poison-sac serves merely as a reservoir whence formic acid is squirted from an orifice at the tip of the abdomen. These stingless ants, therefore, first bite their enemy with their jaws, and then spray poison into the wound —a somewhat cumbersome method, involving two separate and distinct operations. But ants are very agile, while the extraordinary flexibility of their "waist" (i. e., the region between the thorax and the abdomen) enables them to direct their poisonous discharge to almost any point of the compass. Moreover, stingless ants often make effective use of their poison without coming to close quarters. When a nest is attacked and partially demolished, the sterile females or "workers" hurry to points of advantage, and eject their formic acid into the air. The pungent fumes tend to disconcert and drive away the enemy; and there can be no question that ant-battles are often won without the infliction of a single wound.

Ants are probably more aggressive than any other insects. They constantly make raids upon neighboring nests, and pillage the stores. Some species, as is well known, actually engage in campaigns for the sole purpose of obtaining a supply of slaves. Slave-making ants usually attack the communities of species smaller than themselves, and after terrorizing or driving out the adult inhabitants, carry off all the grubs and pupæ that they can find. These they convey to their own nest; and when the mature ants appear, they are caused to play the part of domestic drudges in the nest of their captors. The slaves prove themselves industrious and docile, and it is a remarkable fact that, although they are apparently free to come and go as they please, they never attempt to escape. It has been proved that certain ants are completely dependent upon their slaves. They are fed, cleaned and even carried about by their indefatigable helpers; and if by chance they should be deprived of this assistance, they absolutely refuse to eat, and soon die. One rare European ant has no worker caste. After mating with a male, the female obtains access to the nest of another species. She then kills the rightful queen, and (by what arts has not yet been discovered) contrives to ingratiate herself with the worker population. The last serve their new mistress faithfully and tend her offspring; but as no more worker eggs are laid, the prosperity of the kingdom steadily declines. Before its final dissolution, however, the alien queen will have become the parent of a numerous progeny which will sally forth at the appointed season to accomplish the downfall of other nests. The usurper ant is called *Anergates atratulus*, while the species which it victimizes is *Tetramonium caespitum*.

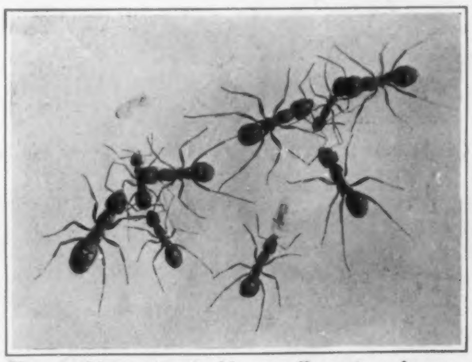


East Indian male beetle with developed forelegs for arresting the female.

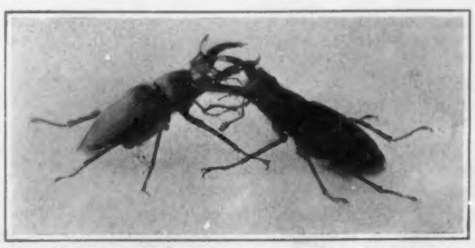
The acid discharge of a bombardier ant disconcerts its enemy.



The giant hercules beetle carrying off its mate.



Slave-making ants attacking smaller ants and carrying off pupae.



Male stag beetles in courtship warfare. The victor carries off the female.

The courtship warfare of male insects is especially interesting. Among the "stag-beetles" of the family *Lucanidæ*, several males often fight desperately for possession of a female, buffetting one another with their enormously developed mandibles, and evincing no little skill in their methods of attack and of defence. In the height of the breeding season, these insects are so much occupied with their rivalry that they seem to lose all sense of fear. Thus, a cautious observer may often witness the duels, and even obtain photographic records of them. In the presence of a female, two male stag-beetles have been known to fight upon the surface of an ordinary table, before the lens of a camera. The victor in a courtship duel will often seize the female with his jaws, and push or carry her to a safe retreat.

In many cases the strangely shaped "horns" which are carried by scarabid beetles upon the head and thorax appear to be specially provided as implements for holding and translocating the female. The mighty Hercules (*Dynastes hercules*)—one of the largest known beetles—has been seen to carry off his mate in this way, after having won her in fair fight with his rivals. The males of other beetles, such as the species shown in the accompanying photograph, have specially developed forelimbs for grasping their mate, supposing she should prove coy at any time and attempt playfully to run away.

Scorpions are not insects; but they are sufficiently close in relationship to be included in the subject of this article. They are most interesting creatures in captivity, and if several specimens are kept their methods of warfare may be studied. In the photograph reproduced herewith, the right-hand scorpion has seized a cockroach, and instantaneously killed it with a blow of its sting. It is now in a defensive attitude, prepared to fight for its booty with a hungry rival. Note the cautious advance of the latter, with nipper claws extended in readiness to ward off a blow from the other's sting, and tail slightly curved in readiness to lash out with its own. The scorpion which has seized the cockroach, on the other hand, is crouching backward, ready to spring forward and deliver a thrust with its deadly weapon, which can be plainly seen at the end of the tail, curving forward and downward, with the poison bag just above it.

Blondel Becomes an Academician

THE French Academy of Sciences recently elected Prof. André Blondel as a member in the place of the deceased savant Cailletet. This well known scientist is especially known for his work in the electrical field, and he occupies the first rank among electrical physicists for his researches upon electrical waves, resonance, synchronous motors, photometry and the like. What is remarkable is that he is bed-ridden for the last ten years, and directs his pupils and assistants in the construction of the electrical apparatus which he invents, among the most remarkable of these being the oscillograph for observation of the forms of electrical waves and their photography.

The Motor-driven Commercial Vehicle

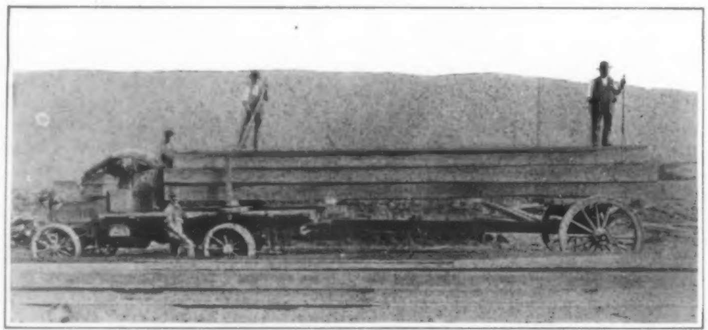
This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The Editor will endeavor to answer any questions relating to mechanical features, operation and management of commercial motor vehicles.

Hook-and-ladder truck hauled by a gasoline tractor.

Advantages of Tractor Transportation

IN the early days of practical motor trucking, which, incidentally, were not so far back but that they are easily brought to mind, it was by no means a trivial matter to construct a machine that would operate consistently and economically under normal working conditions. If a truck would do what it was built to do it was all that was expected. It did not take long, however, to discover that the load actually carried on the body of a truck did not call for the exertion of anything like the normal power of the motor under ordinary running conditions, and that a trailer, coupled up behind the loaded truck, could well carry a very substantial separate load and be hauled at reasonable speed without over-taxing the motive power, though of course, the hill-climbing ability of the machine would be correspondingly curtailed.

Some idea of the loads that can be handled in this way may be gained from the fact that a standard five-ton truck has hauled a trailer load of 45 tons, including the trailing vehicle, and even this does not represent the greatest weight that has been trailed by a five-ton machine. Obviously such a powerful transportation system could not well be neglected, nor has it. Of late years the trailer principle, with various modifications, has received much attention and excellent results are being obtained in actual every-day work.



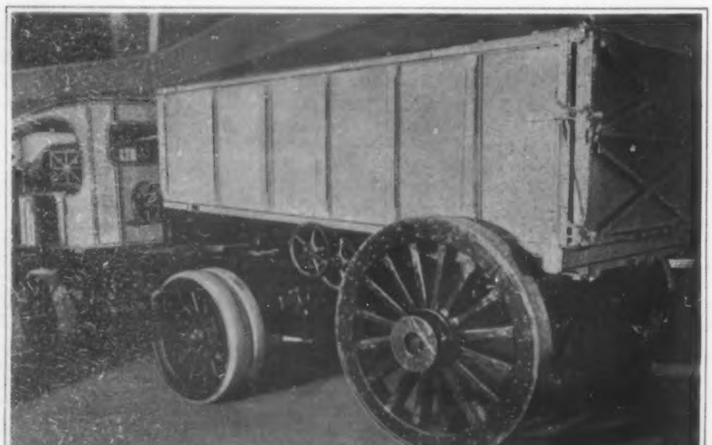
Five-ton truck with a lumber trailer.

Gas-electric tractor; a motor in each inclosed wheel.

While in Europe the wagon train, consisting of a tractor and several trailers, has been quite extensively developed and employed, in this country more attention has been given to what may be termed the semi-trailer system. Briefly, the semi-trailer unit consists of a motor truck, usually having a short-coupled chassis, carrying a sort of fifth-wheel or turntable on which is mounted the forward end of a two-wheeled trailer; the whole of the load is carried in the body of the two-wheeled trailer. By calculation as to the position of the turntable on the chassis and the proportion of the load carried on the chassis and on the trailer wheels, any desired distribution can be effected, and the unit has the advantage over the ordinary truck-and-trailer outfit that it occupies considerably less space, is more easily maneuvered and is less expensive to construct. The rear wheels are of ordinary wagon construction with steel tires, though it is necessary to employ considerably heavier wheels than would be required for horse trucking because of the increase of speed and the high mileage obtaining with the use of power.

The steel-tired rear wheels, costing, as they do, far less per mile than the rubber-tired wheels of the truck proper are made to carry the greater part of the load, the weight on the chassis being just sufficient for good traction. This makes it a simple matter to proportion the load on the rubber tires so that they will work under

(Concluded on page 170)



Motor truck with short-coupled chassis and two-wheeled trailer.

Three-wheeled electric ash cart.

Advantages of Tractor Transportation

(*Concluded from page 168.*)

favorable conditions. It is known that a truck of this type, having a capacity of eight tons, has been run for twenty months on a single set of tires, and even then only two were unfit for further service, the two front tires remaining in service for four months after two new rear tires were applied. This of course results in a very marked operating economy, as tire expense in heavy trucking is a serious item.

A machine of peculiar design that has been evolved especially for service as a tractor has but three wheels, the two in the rear being drivers and the single front wheel of course the steering wheel. So far as the rear end of the tractor is concerned, it resembles the ordinary type of gasoline truck with final drive through sprockets and chains, and the motor housed in the conventional hood with the radiator in front. The single front wheel, however, serves to give the machine a decidedly unusual appearance. A forward extension of the frame—or, more correctly speaking, a separate steel casting riveted to the forward end of the main frame—carries a socket in which turns the shank of a heavy fork straddling the front wheel. The fork structure is not continuous to the wheel hub, but on each side there is a full elliptic spring which provides an elastic suspension. Steering is effected by means of the usual hand wheel which is connected to the top of the fork pivot through a long shaft, which passes over the top of the motor hood, and reducing gears contained in a casing at the top of the socket. For service where conditions affecting traction always are good this tractor is fitted with steel-tired rear wheels; more commonly, however, rubber block tires are employed. The king-pin and turntable upon which the front end of the trailer member rests are directly over the rear axle; the axle and wheels of course are proportioned to carry the load, while the front wheel is loaded only sufficiently for steering purposes, and its load is practically constant, regardless of the weight carried in the trailer body.

For some years the gasoline-electric or mixed system of propulsion has been in practical service in this country, and vehicles of this type, with four-wheel drive and steer, have been successfully put into service as tractors and semi-tractors. In one such machine the engine, mounted under the floorboards and the driver's seat, is direct connected to a generator, which supplies current for four electric motors, one being inclosed in each of the steel disk wheels. Each motor is, in effect, part of the stationary axle and its armature remains in a horizontal position while the wheel rotates around it. Each end of the armature shaft carries a pinion, and each pinion meshes with a large gear ring on the inside of the wheel, close to the rim. The armature necessarily is slightly skewed so that the pinions can mesh with opposite gear rings and thus both drive the wheel simultaneously. An equalizing device in the armature shaft permits slight relative movements of the pinions in the manner of a differential gear. Vehicles of this type also are fitted with batteries, the battery machines being suitable chiefly for comparatively short distance service.

A tractor with four-wheel drive and steer, dividing the work, as it does, between all four wheels, requires a different distribution of weight from a rear-wheel driven machine. Therefore the turntable carrying the front of the body is so located that the rear wheels receive but little more weight than the front wheels. The advantages claimed for this arrangement are that as all work is divided between four tires, no one or no pair is overloaded or overtaxed, but rather, all are working under favorable conditions. Further, the four-wheel steering system is said to facilitate maneuvering in close quarters and running in the reverse. The convenience of electricity as a motive power for auxiliary purposes has led to the installation on these trucks of a number of electric hoisting bodies, winches and the like.

While a short-coupled chassis such as is used in both the cases referred to usually is best adapted to semi-tractor work, it by no means follows that a long or standard chassis will not answer the purpose. On the contrary, not a few standard size trucks are employed, either regularly or occasionally, as semi-tractors. One of the purposes to which they are particularly well adapted is the handling of long timber, which cannot be mounted on a single body and, besides, often is of greater weight than can well be carried by a truck that may be well able to haul it on a trailer.

One of the niches that the semi-tracter has filled very satisfactorily is that of motive power for very heavy fire apparatus, the horse-gear and front wheels being removed and the front of the apparatus mounted on the turntable of a semi-tractor. The great weight of these pieces has made them clumsy and slow-moving when horse-drawn, besides being capable of moving only forward, in most cases. The application of the semi-tractor has converted them into modern motor-driven machines at a cost far below that which would be incurred in building complete new pieces, of similar design but with motor propulsion built in. Water towers, hook-and-ladder trucks, steamers and other types of fire apparatus have been equipped in this way, and many such are in constant service.

Front wheel drive, which of course embodies the tractor principle, is receiving far more attention at present than it has in the past, largely, no doubt, because mechanical engineering has risen to a point where the difficulties that formerly were more or less baffling can be overcome. The electric systems, with motors mounted as units with the wheels, are readily applicable to front-wheel drive, but there also are several mechanical driving systems that have given good results. A new French system, for instance, which is being introduced into this country, shows the capabilities of the principle. A motor, with transmission gearing, change-speed system and final drive complete, is mounted on a pair of wheels, together with the driver's seat, gasoline tank, radiator and so on. The rear end of the short frame is extended in such a way that almost any sort of body can be bolted in place, the body of course having its own wheels, which may be, and preferably are, if economy is a consideration, of the ordinary steel-tired type. The weight of the power plant is so balanced that the body has to carry only its own load.

Drive from the vertical four-cylinder motor, which is placed in the conventional position, is through a cone clutch and a sliding gearset operated in the usual manner. Final drive is through a cross shaft which carries spur pinions meshing with spur gears bolted to the wheels. Universal joints located in the planes of the steering pivots permit steering and driving at once. The gears are of course inclosed as well as the cross-shaft and its joints; incidentally, there also are universal joints where the shafts emerge from the differential housing, so that all possible disaligning strains are provided for.

A somewhat similar driving system is employed in a machine that has the distinction of being the largest tractor that has been built in this country, and is used by the railroad company that constructed it for hauling loaded freight cars through city streets where a locomotive is impracticable. The huge tractor, which drives and steers through all four wheels, derives its current from a storage battery and weighs fourteen tons, has a motor for each pair of wheels, driving through reduction gearing and cross-shafts universally jointed. The joints are peculiar in that they are inside the pinions—in other words, the pinion forms the outside of the joint. Obviously the pinions are directly in line with the steering pivots. Steering is effected by means of a wheel of the marine type located in a cab that has the appearance of a regulation tugboat pilot house.

INQUIRIES

Inquiry No. 9316. Wanted the names of manufacturers and manufacturers' agents who make patented articles and other useful devices which appeal to the public and which can be used in a mail order business and by canvassers.

Inquiry No. 9317. Wanted the names and addresses of manufacturers of good selling articles that would appeal to the public where exclusive sale in certain territories can be arranged for; both to sell to the trade and through sub-agents in a house-to-house canvass.

Inquiry No. 9318. Wanted rollers and other appliances for extracting water and moisture from refuse, such as coir dust, with special reference for using it as a fuel.

Inquiry No. 9319. Wanted the name and address of concerns manufacturing novelties in table or pocket cutlery for the wholesale or mail order trade.

Inquiry No. 9320. Wanted an article suitable for large manufacturing—plant equipped for making Boats, Marine Engines, etc. The plant would be capable of making almost any article. A large wood-working establishment is also operated in connection with the metal shops.

Inquiry No. 9321. Want name and address of a firm who could make a machine for turning out rat buttons. The machine must be capable of making the dough of the exact size required, and also a machine to manufacture the tins and a machine for placing the dough in the tins. Preferably this machine should do all of this work in one operation.

Inquiry No. 9322. Wanted the names and addresses of concerns that can make clarinet mouth pieces out of glass.

Still another application of the front-wheel drive system is found in the conversion of the two-wheeled ash carts that are familiar in most large cities to battery trucks. A heavy fork, with geared steering mechanism, is mounted with a wheel in which an electric motor is inclosed, the wheel being similar to those in the electric tractors already referred to. The construction is extremely rugged, as is necessary with the class of drivers that must be put on ash and rubbish carts, and there is nothing that exposure to the weather can affect injuriously.

The Fire Convention at New York

THE annual convention of the International Association of Fire Engineers, which assembles in New York city during the first week of September, will be of interest as emphasizing both the importance and the status of the fireman and the fire department in present day American life.

Aside from the glamor of excitement and heroism which always has been connected with the profession of fire-fighting, there is now an economic and engineering side that is becoming increasingly prominent, so that the modern fireman with motor apparatus, high-pressure mains, special permanent equipment within lofty tower buildings, fire drills in crowded factories, and other twentieth century conditions, not to mention his work in securing proper and safe building and maintenance, is a very different person from the rough-and-ready worker with undaunted physical courage of a not distant past. Indeed, in the general awakening of interest in conservation and municipal efficiency, the fireman is not the least concerned; for he of all public servants realizes that his true rôle is not the heroic fighting of spectacular and devastating conflagrations, but the prevention of all outbreaks of fire.

Unfortunately municipal authorities, unwilling to lock the door until after the theft of the horse, too often fail to give proper attention to the demand of the fireman for adequate equipment and to his suggestions for effective building regulations and the enforcement of safe conditions of maintenance. One has but to attend such a convention as this to realize how earnestly the better grade of fire chiefs are devoting themselves to the improvement of building methods, and how they are acquiring the engineering as well as the practical knowledge now demanded in their profession. It is in this connection that the coming meeting in New York is of special significance aside from the professional papers presented and discussed in formal session, for it will be held in a city where the technical side of fire-fighting has been highly developed. Here a fire college is maintained for the instruction of officers and men of all ranks, an institution by the way which not only is being copied, but is utilized for training officers of other cities. In this fire department, motor equipment has been developed not for racing but for practical service. A high-pressure service and a large fleet of powerful fire-boats have made a very widespread conflagration practically impossible.

All of this represents a branch of municipal engineering of a high order. The same problems are also interesting other cities, so that the fire chiefs from the cities of America, Canada, and Europe, who will assemble in New York will have much to see as well as much to give from their own experience. Not only will there be demonstrations of equipment and methods in addition to a large exhibition in the Grand Central Palace, but an elaborate series of practical tests of apparatus from many manufacturers carried on by mechanical engineers so as to secure comparative and valuable results.

Disinfecting Eggs.—A Magdeburg, Germany, inventor, Walter Kulenkampff, has patented, No. 1,063,043, a method of preserving and packing eggs in which the eggs are disinfected internally and externally by evacuating and then filling with a gaseous disinfectant which is replaced with an innocuous gas after which the eggs are packed in a bacteria proof wrapper.